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MEDICO-MECHANICAL GYMNASTICS.

By Dr. A. LEVERTIN, Director of the Oestermalms Medico-Mechanical Institute in Stockholm.

FOR many years Dr. Gustav Zander, the originator of this method, studied a system of curative gymnastics with mechanical apparatus, and as his numerous experiments gave him confidence in the ultimate success of his work, he decided to base a complete method of treatment on gymnastics of this kind, and call it the medico-mechanical method. The establishment he started in Stockholm in 1865, in which this method is practiced, he has named "The Medico-mechanical Institute." Since then a large number of similar institutes have been started with Dr. Zander's co-operation, and provided with apparatus manufactured by the Goranssons Mekaniska Verkstad, of Stockholm, under the control and direction of Dr. Zander.

The real object of all gymnastics is to exercise the muscles, and in the Zander method machines are employed for this purpose, as already stated. In the manual method this object is accomplished by using the muscular strength of another person, but in the so-called pedagogical gymnastics the necessary resistance for working the muscles is supplied by the bodily weight of the person who is performing the exercise. In order to give the muscles proper work and exercise, they must overcome a certain resistance, which in the Zander method is provided by the loaded lever arm of the apparatus. Such regular exercise, which must be modified according to the strength of the person, has an effect, not only on the muscular tissue, the diseased condition of which it soon overcomes, but it also strengthens the nervous system, animates the circulation of the blood and the lymphatic flow and assists the organs to perform their respective functions.

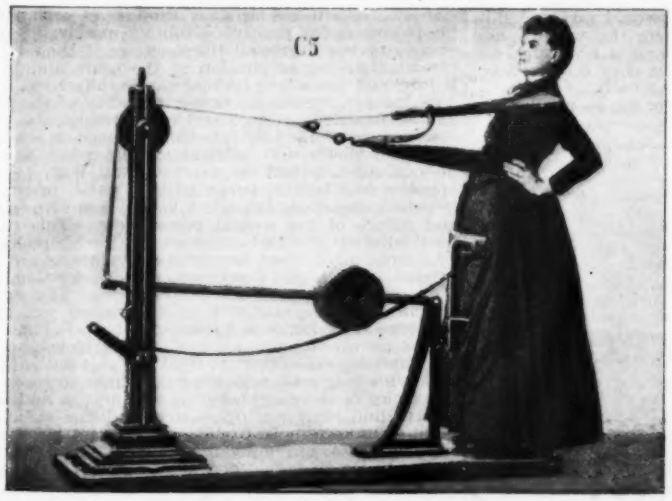
The Zander gymnastic method utilizes not only the active muscle strengthening movements, although these hold the first place, but also the passive movements, that is, such as are made by the members of the body without the help of the muscles in stretching the tendons, ligaments and muscles, and the so-called mechanical movements, percussion, kneading, slapping, rubbing, etc. The Zander method provides a special apparatus for exercising each group of muscles, and therein lies its great advantage. Dr. Zander has also provided an apparatus for measuring with mathematical precision the smallest peculiarities of the heaviest contours of the body and the deviations in the curves in the back and indicating graphically each abnormality, and only by means of this instrument can the extent of the infirmity, the effect of each separate movement and the result of the treatment be obtained with certainty.

The method is of the greatest value in the development of boys and girls who suffer from a weakness which often causes a bad carriage of the body and not infrequently curvature of the spine. The movements used to overcome this weakness must be made to gradually include the entire muscular system so as to restore the disturbed equilibrium of the organs, to direct the development into normal channels and in this way to prevent excitement of the nerves, such as is often caused by the forcing systems used in the schools, with their exacting requirements. After weak children have begun to take this treatment they gradually gain so that they finally possess the same vitality as their more fortunate comrades who are more strongly built or have stronger parents.

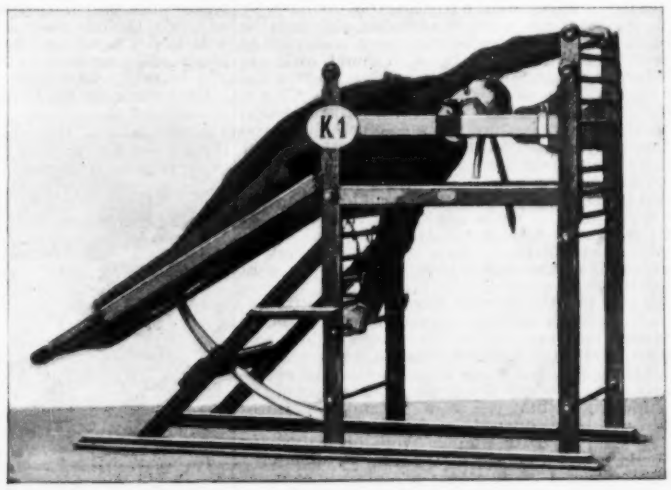
The Zander method gains new ground each year as a dietetic remedy, especially with those who lead a sedentary life,—officials, merchants, teachers. A sportsman uses his muscles while he is young, keeping them in strong, healthy condition, and this exercise becomes a necessity to him; but he is unable to continue it as age approaches and his limbs stiffen, and the Zander method provides just the means he needs for keeping up his exercise and counteracting the weaknesses and infirmities of age.

Finally, we must consider the method from a purely therapeutic standpoint, placing it in line with other methods as a tried remedy offered by science for the benefit of mankind. No prophetic sight is needed to see that in the near future the faculties of foreign medical institutions will recognize the value of the Zander method and consider it worthy of taking its place with the other subjects taught in these homes of science.

A person suffering from heart disease leads a pitiable life, he can scarcely mount a flight of steps without suffering from difficulty in breathing and palpitation of the heart, the least excitement increases his trouble. By the use of a systematic movement cure, especially



STRAIGHTENING THE BODY.



HANGING SIDEWISE.

LOWERING AND BENDING THE ARMS.

DEVELOPING THE CHEST.

VIBRATION IN THE SADDLE.

if taken in time, the life of such a patient may be made much more bearable both for himself and those about him. We know many persons of seventy who have been entirely relieved of the symptoms of heart failure by the Zander treatment, but such a result is, of course, obtained only by regular exercise continued for years.

We have already stated that patients suffering from nervous diseases are much benefited by the Zander system of gymnastics; neurasthenia may be gradually conquered by it, and hysterical and hypochondriacal patients will be much benefited by the movement cure, while remarkable cures have been made in cases of neuralgia; stomach troubles have been alleviated and in many cases cured; and what excellent results we have been able to obtain for those suffering from abdominal troubles, from catarrh of the stomach, where the vital energy has been increased and the different organs aroused to greater activity by strengthening the muscles; from constipation, that trial and worry of many patients, to female diseases, where the Zander method works hand in hand with massage.

But the diseases which affect the entire constitution more decidedly are also successfully treated by this method, especially when it is not counteracted by lack of confidence and perseverance on the part of the patient; and we can also boast of many cures in cases where there is a deficiency of blood, with its varying symptoms, such as corpulence and fatty degeneration. For muscles and joints that are not in a healthy condition no remedy has been thought so highly of in Sweden, even from very old times, as the movement cure, kneading, rubbing, etc., in a word massage, assisted by suitable baths or medical treatment. When the muscle or joint has become supple the systematic resistance movement is the safest means for helping it to perform its normal functions.

The results obtained by the treatment of scoliosis by the Zander system are most remarkable, although we have often had to contend with many unfavorable circumstances, and as we go hand in hand with the orthopedist in our aims and work, he should greet the Zander apparatus as a good ally and great help, for it is impossible to put a scoliotic patient off with a bandage, a method which is indeed very comfortable for the physician, but does not in the least enable the patient to correct the evil by the use of his muscles.

The gymnastic cure has demonstrated its importance in several other ways of which there could have been no suspicion ten years ago. We refer to the part it plays in public interests, for it is used in institutions for the treatment of the injured, which are a result of the accident insurance law which went into force in Germany in 1884.

The Zander movement cure shows to no better advantage than when used in connection with a spring or bath cure, in support of which we can point to an experience of sixty or seventy years in Sweden. The system is more effective when the dietetic laws of life are observed, as has been demonstrated in many of the greatest foreign bathing resorts, and Zander institutes have already been opened in Baden-Baden, Wiesbaden, Aachen, Wildbad, Ragaz, Nauheim, Karlsbad, Marienbad, and at baths near Vienna. These have set the example and many others are already contemplating the erection of Zander institutes. The one in Baden-Baden proved such a success that the state has erected a second one. In Wiesbaden there are two complete Zander institutes and one institution in which the patients may have a choice of apparatus.

There are now in the various parts of the world thirty-three institutes which are fitted out entirely with the Zander apparatus, and fifty-two in which these and other apparatus are provided, so that the patients can have a choice of apparatus.—Der Stein der Weisen.

EFFECT OF HEAT UPON ANIMALS.

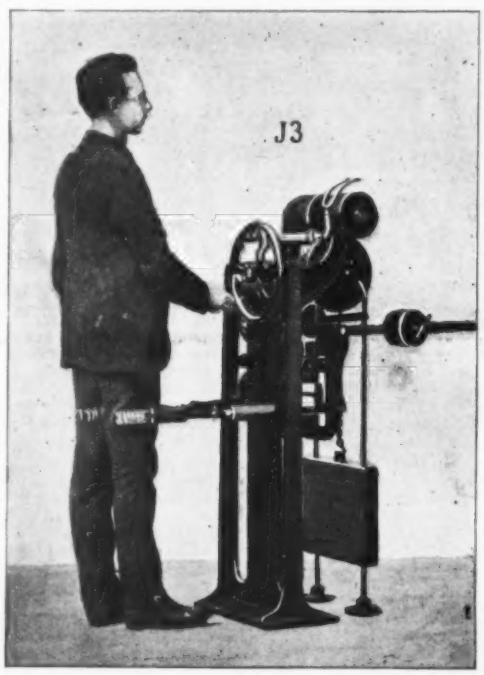
NERVOUS exhaustion from heat is probably more common among horses than is supposed. They suffer not only from the depression of tone caused by the temperature, but from the worry and excitement caused by flies and insects, which madden the working horse, with no time or means to rid himself of them effectually. The network jackets and flaps granted even to smart carriage horses in hot weather are a real benefit to them, and if cows could be provided with similar but more extensive protection, it is certain that the yield of milk would be increased by the respite from constant nervous worry.

That it is the flies which accompany heat, rather than the heat itself, from which animals suffer when wild, or domesticated animals when at rest, seems proved by their habits in the New Forest. There the wild ponies and cattle all leave the woods in the midday heat and congregate in what are known as "shades." But these "shades" are shadowless, being generally some quite open and elevated spot, with no trees near and in the full glare of the sun. There, however, the tree haunting flies and ants are fewer, and if there is a breeze it can usually be felt. They prefer to face the heat to enduring the heat insects, and more especially the crawling New Forest fly. In ordinary meadow land cattle collect under trees toward midday, and in the afternoon, if it be possible, gather in the ponds, where they stand so deep that the lower and most sensitive parts of their bodies are completely covered by water. They thus gain coolness and protection from insects at the same time; but there are not many field ponds which are so large or accessible from the bank that cattle can enjoy themselves in this way, which, as Gilbert White remarked, was equally good both for the beasts and for the fish, which gather round to catch the flies.

During the great drought two summers ago horses became almost aquatic animals where this was possible. They waded shoulder deep in the Thames, eating water plants and seeking coolness, and emboldened by these excursions, even swam the river and invaded the fields beyond. In the same year a small, deep pond in a meadow beyond Hanwell, visible from the Great Western Railway line, was used as a bath by four horses for the greater part of each day. They stood in it with the water almost level with their backs, and presented the appearance of huge river animals of the tapir kind floating in the pool. It seems clear from this that they derive the same refreshment from the application of cold water to the skin which other perspiring animals do. Humane cab drivers recognize this fact by driving their horses as nearly as possible into the shower from the rear of a watering cart, and there is little doubt that an occasional sluicing from a hose pipe would probably do much for the health of the draught horse in the dog days. Deer both bathe and seek a draught in such weather. On one of the hottest days of last summer a red deer hind took possession of an islet in Penn Pond in Richmond Park, swimming there and back, and spending the greater part of the morning in Robinson Crusoe fashion on the damp islet.

Sheep do not suffer from the highest temperature of the English climate if shorn and left quiet with plenty of water. But any driving or traveling causes them the utmost distress at such times, and a careful shepherd prefers to make the common and daily change of pasture early in the morning or late in the evening. Dogs do not often die of sunstroke, but if made to work in great heat have violent fits and foaming at the mouth. Spaniels, if used for rabbiting in September, are very liable to these fits, and are cured by pouring cold water on the head and back of the neck. "Mad dog!" is the silly cry usually raised on these occasions, though there is not the least cause for alarm, as the flow of saliva is quite harmless. When lying about the house at their ease individual dogs seem to take different views of the effects of hot weather. Most seek some cool material to lie on—tiles or grass for choice, rather than rugs or mats. They also lie on their sides with their legs extended, to admit the air to as much of the skin as possible, instead of lying curled up to exclude air, as in winter. Some seek a draughty passage, or lie at an open window, and nearly all revel in a bath. Curiously enough, however much a dog enjoys a swim in hot weather, it scarcely ever goes off of its own accord away from the house to take one. The writer once owned a setter which would do this. But, as a rule, though they know where the water is, and will, in dry localities, run away half a mile when out for a walk, in order to take a dip, they do not leave the house by themselves to have a bath.

Cats never bathe, though tigers do so regularly in



TREATMENT OF THE LEGS.

the Indian heats, and will sit for a long time up to their necks in water. But the cat seems to rejoice in any degree of heat, and to be willing to sit in a cucumber frame, or a greenhouse, or on a lead roof on the hottest days of the year. On the other hand, they become very thirsty in such weather, and in the backs of small London houses climb up to the cisterns to drink. Mr. Hagenbeck, the owner of the Thier Park, at Hamburg, has found that his polar bears actually enjoy the hottest sun of midsummer, and lie out exposed to its rays when other animals are distressed by the heat. On the hottest day which he remembers to have felt in Hamburg, he went round the gardens at midday to see if the animals needed any special treatment. Cases of human sunstroke had been dropping in at the hospitals all the morning, and he was not surprised to find both a tiger and a leopard in a fit and almost insensible. But the polar bear had left its inner cage and stretched itself flat on the hot stones, where it could enjoy to the full the excessive heat of the North German midsummer.—London Spectator.

PROPHECIES OF BACILLI.

A CORRESPONDENT sends us the following extract from the "Life of Aly Pasha," who was governor of Janina about the beginning of the century:

"Aly Pasha 'could not help laughing when the French consul [Mr. Pouqueville] informed him that one of the professors at the College of Janina asserted that the lake [the subject of the conversation] ran underground, and that it formed the Vistriza [probably a river]. These people,' replied he, 'never see things like others. Yet he has been here for some time, but, like his brethren, he prefers adhering to old traditions rather than give himself the trouble of investigating facts. I know some (looking at his lieutenant-general) who have a great talent for this ingenious art of story making; what is your opinion, wise one?' [viz., the lieutenant-general]. The lieutenant-general, quite discomfited, could not answer a word. 'That man,' continued Aly, 'is one of those who see in the dark. Would you believe it? He pretends that the plague is composed of a vast number of minute animaleules, which would be visible through a magnifying glass, if one could be procured of sufficient power.'"

Bacteriology as a more or less exact science, is yet very young, and probably all that has been discovered as to the nature and work of these organisms is as nothing to what remains undiscovered. But although the last thirty years have seen such important work done in this field, it is interesting to note how for centuries back the idea of disease being caused by minute organisms has been floating in men's minds. Long before the days of Aly Pasha's friend we find references to germs and animalcules as being possible causes of disease. To say nothing of Harvey, Leuwenhoek and the early microscopists described small bodies and hinted at the possibility of diseases being caused by their agency. Francisco Redi, born in 1626, also refers to the matter.—Lancet.

THE EFFECTS OF SNUFF ON THE HUMAN SYSTEM.*

PERHAPS there is no article of commerce so common or more in demand, or has, comparatively speaking, a greater sale than that of snuff, especially in the Southern States, and there is certainly no article of commerce that is getting in its deadly work more surely and insidiously. Physicians generally seem not to have taken into due consideration its vast and deadly effects on the human economy, especially on that of the female organization, for by far the greater consumption of this article is by the women and girls of the South, mothers and daughters rivaling each other in the consumption of this noxious article.

It is a well attested fact that snuff is an acro-narcotic poison and a positive debilitant, paralyzing to a greater or less degree all the functions of the nervous system, inducing palpitation of the heart and heart failure, and also a long train of cardiac affections. We have nausea, vomiting, chronic torpidity of the liver and its functions, vertigo and neurasthenia, the peristaltic movements of the intestines checked or sensibly impaired, micturition deficient and irregular, and at periods characterized by an unnatural flow, loss of appetite, foul breath, irregularity of pulse, insomnia, impaired digestion, imperfect vision, loss of memory and failure of the mental powers, etc. This statement is not exaggerated, overdrawn, or too high colored. Of course, all of these enumerated symptoms are not present in each and every case of snuff poisoning, but some of them are present in every case. The entire system is impregnated with its deleterious poisonous influence and odor, even to the breath and skin, as is it also on the nursing mother's milk. How often is the physician called upon to treat a female patient; he makes his diagnosis, prescribes medicines to meet the exigencies of the case; what is his surprise and chagrin to find his prescriptions and medicine valueless, because, unknowingly to him, the patient is a snuff slave, and its use daily and hourly has thwarted and counteracted the beneficial action of the prescribed medicines. Physicians cannot be too careful in making very particular inquiry as to the habits of their patients; indeed, it is their positive duty to do so, both to themselves and their patients, of course with all due courtesy and politeness.

Permit me to give two typical cases coming under my personal observation. A gentleman came to me to consult me in regard to his wife, and requesting me to go and see her, saying she was troubled with nervous tremors, palpitation of the heart, insomnia, and general debility. On visiting her I found her condition about such as described by her husband. Skin very sallow, tongue white but browned over by snuff, breath repellent with the foul odor of snuff, and her general system in a very debilitated condition. I found upon strict inquiry that she was using, and had been using, a bottle of snuff per week, at all times during the day, and frequently at all hours of the night. Madam, said I, are you a clean woman? She looked at me rather indignantly and replied that she claimed to be so, asking me did I see anything about her person, apparel, or house indicating otherwise. I replied that I did not. Still, I said, madam, you are not clean physically. I will apply a test, or rather, you can apply the test yourself. If, upon applying said test, you pronounce yourself clean, I will treat your case free of charge. The challenge was accepted in good faith. I then directed her, on retiring at night, to divest herself of all clothing, envelop herself in a well wrung wet sheet, lying in the same until early dawn, then remove the sheet and hang it out in the open air, and then tell the result of the experiment. She tried the experiment the same night and I saw her the next day, and she gave up without argument. In this case the use of snuff was totally abandoned at my request, and the patient treated strictly on hygienic principles, and in consequence she became a healthy, hearty, stout woman, and furthermore, a very grateful one, always giving great praise and sincere gratitude to the doctor.

The other case I will refer to quite briefly. I was called hurriedly from home to go a distance of sixty miles to see the only daughter of Judge P., who was pronounced by two well known and competent physicians to be dying with pulmonary consumption. I was not sent for to take charge of the case, but merely to give my opinion in the premises. After a very careful and thorough examination, my diagnosis was snuff poisoning. After the death of the patient an autopsy was permitted by the parents. The lining membrane of the lungs was found to be thoroughly saturated with snuff, and also nearly every internal organ of the body. After the death of the young lady, a young female negro domestic said that her young mistress had used a bottle of snuff per week, charging her not to let her mother or any of the relatives or household members know anything about her using the article anyway.

It is estimated that twenty-two acres of land are necessary to sustain one man on fresh meat, says the American Grocer. The same space of land, if devoted to wheat culture, would feed 42 people; if to oats, 88; potatoes, Indian corn and rice, 176; and if to the plantain or bread tree, over 6,000 people.

* W. K. Grayson, M.D., Florence, Tex., in Texas Medical News.

PHŒNICIAN MINING.

IN a paper on "Ancient Mining," read before the Institution of Mining and Metallurgy (England), Mr. A. Cooper Key, the author, said:

The Phœnicians undoubtedly derived their knowledge of mining from the Egyptians, and practiced it in their own country, which, however, was poor in its mineral resources, no metal of importance existing there save iron. In seeking riches they were, therefore, driven away from their country, going gradually farther and farther afield. Their journeyings will now be noticed. The first place to which they turned their attention was "the island"—i. e., Cyprus. Here they worked copper in the southern mountain range near Thamasus. Ancient workings have been noticed by travelers near Thamasus and Soli. These workings were not described by the old writers, nor have they been subjected to modern scientific exploration.

The derivation of the word copper is from Cyprus, for this metal was called æs Cyprium—brass of Cyprus—by the Romans, and, the first word having been dropped, it became Cyprium, then Cyprum, and, finally, Cuprum. There were silver mines as well as tin mines at Thamasus, and in the thirteenth century B. C., the Phœnicians opened out the gold treasures of Thasos, an island in the Thracian Sea. Herodotus, who viewed these mines after they had been abandoned, informs us that the miners had turned over a whole mountain. Traveling on, the Phœnicians explored Sardinia, and, it is believed, worked lead there; for in the vicinity of the lead mines, enormous heaps of scoriæ exist, and pigs of the metal have been found buried in them, dissimilar to those of Roman manufacture. The weight of these pigs is about 28 to 37 kilogrammes; some of them are of lead and others of copper. Still pursuing their western course, these early miners reached Spain, a country of overwhelming mineral wealth. Some writers have drawn a parallel between Spain and America, saying that the former country was to the ancients what the latter is to us; but Professor Rawlinson, following out the same idea, goes farther than this, for he says: "Spain was the Peru of the ancient world; in fact, it surpassed its modern rival, for it not only produced gold and silver, but copper, iron, lead and tin in addition. They attacked the silver mountain—i. e., Sierra Morena—which is situated near the lower course of the River Guadalquivir. The richest mines of silver were near Sephela, the site of which has been located with modern Seville.

Gold was the least abundant metal: it occurred in the bed of the Tagus, and there were mines for it in Gallicia, in Asturias, and elsewhere. There was always some silver mixed with the gold, the proportion varying from 3½ per cent. to no less than 12½ per cent. Copper was found at Cotini, which is situated near Gades—the modern Cadiz. Tin was not found near the surface, but was mined in Lusitania, to the north of Lusitania, and in Gallicia. Lead was yielded in greater abundance, and was found in Cantabria, in Boeticia, and many other localities; and it was exported by the Phœnicians, the Carthaginians and Romans. It is thought that the discovery of silver was accidental, and in consequence of the burning of a large forest, which caused the metalliferous metal to melt, and the silver was found in lumps on the ground. When the Phœnicians first landed in Spain, silver was regarded as of little account by the natives, and they were able to exchange articles of little value for large quantities of it. The mines in Iberia were carried down many stadia* in depth with pits, shafts, and sloping paths. It was found that the veins of gold and silver were more productive at great depths.

The metallurgical processes adopted are interesting, but details of them are scanty. The gold ore was melted over a slow fire, and purified by vitriolated earth. In a method pursued in somewhat later times the ore was crushed and washed carefully until the earth was cleared away and only the gold remained. After washing, the pulp containing the grains of metal was put into white clay crucibles, which were placed in a furnace heated to melting point, which temperature was attained by the aid of a blast produced by bellows. Dross or skim forming on the top of the mass was skimmed off, or the metal run off by opening a stopcock. In order to obtain a metal of greater purity the melting process was sometimes repeated. The slag from gold was as a general practice crushed and treated again so as to obtain as much gold as possible. Some gold, however, always remained in the recrement, as the ancient metallurgists were unacquainted with the use of mercury, although they were aware of its existence in Spain. Silver was dealt with in smelting ovens, the chimneys of which were carried high up into the air, as the fumes which were given off were dangerous, or even deadly. This was due to the presence of arsenic in the ore and also, to a lesser degree, of antimony. According to Diodorus Siculus, the shafts sunk by the Phœnicians were, in some cases, half a mile or more in depth. From these shafts horizontal levels or adits at various levels were constructed; then from these main levels sprang lateral galleries, either straight or very crooked. The veins were perseveringly followed, and when a trap fault was encountered it was cut through or the road turned. The danger to the miners from falls of the roof was well understood, and it was customary to support it by means of wooden posts. Where the rock was sufficiently strong to allow of it the road was arched to give additional strength. Strong springs of water were very often struck, in which case the mines were drained by making a new adit to a lower level; where this was impracticable the workings had to be abandoned; but by the invention of the screw pump of Archimedes, about B. C. 220, it was possible to pump the water to the surface.

There is good authority for saying that this method of drawing water was, as late as 1811, used both in Spain and Portugal. Nearly all the tin used by the ancients was procured by the Phœnicians from the Cassiterides. A great deal of speculation has been indulged in as to their position, and many authors have been at great pains to endeavor to prove that they were situated to the east of Phœnicia in the neighborhood of India. The great weight of evidence and the testimony of the most learned archæologists is, however, that they corresponded to the Scilly Isles and Channel Islands, and, more particularly, Cornwall, which was in those days supposed to be separated from the mainland.

* Stadium. A Greek measure of length 606 ft. 9 in. English.

Two derivations have been suggested for this word Cassiterides, but they may be independent or in reality one. "Kassiteros" is the Greek word for tin; but possibly, this is the equivalent of the Hebrew word "katseh"= finis, meaning the extremity of the earth, which the coasts of Britain would have been to the ancients. The Phœnicians had an important station at Gades or Gadiera (the present Cadiz), which was built 1100 B. C. Here they made boats, and had repairing shops. The word "Tharsish," of such frequent occurrence in the Pentateuch, is considered to refer generally to the coasts of the Mediterranean. From Gades these ancient sailors voyaged to Cornwall, a distance of about 1,000 miles in a direct line, but considerably farther by keeping near the coast line, the route which they probably adopted. It is believed that communication between the two places was in the earlier days by sea throughout; not as in later times, to some port in the north of Gaul, and thence across the mainland.

To have performed this rough sea passage the Phœnicians must have possessed large seaworthy boats, very different, indeed, to the small coracles used by the Britons. The commencement of the Phœnician working in these islands has been assigned as about twelve centuries B. C. Diodorus Siculus, writing just before the Christian era, and repeating what has been told by more ancient chroniclers, giving an account of the work of the inhabitants of the west of Britain, says: "They prepared the tin, very carefully working the earth which produces it; the ground is rocky, but has in it earthy veins, the produce of which is brought down and melted and purified. Then, when they have cast it into the form of tubes, they carry it to a certain island called Iklis. During the recess of the tide the intervening space is left dry, and they carry over abundance of tin to this place in their carts."

Regarding the position of the island Iklis, various theories have been advanced, some authors even going so far as to suggest an identity with the Isle of Wight. This seems exceedingly problematical, and would appear to fail when the great distance for transport by carts is considered. The most reasonable view to take is that it corresponds with St. Michael's Mount.

The Phœnicians were not Jews, but Canaanites, worshipers of Baal and Ashtoreth. Possibly they employed Jews as their slaves. The "Jews' houses" of Cornwall are of a much later era (Saxon and Norman times). Truro Museum contains a bronze casting of a bull about 2 in. in height, with many distinguishing features of Assyrian bronzes. Moreover, a similar figure has been discovered in Babylon. In 1849, Mr. Richard Edmonds discovered near Marazion a vessel resting on charcoal ashes, charcoal and slag being also associated. This was conjectured to be the remains of an ancient bronze furnace, but Professor Hunt is of opinion that it was only used for domestic purposes, on account of the "action of the molten tin upon a vessel containing copper in its composition, which would be disastrous to the vessel." The tin worked was probably of detrital or alluvial origin.

The Phœnicians jealously endeavored to keep the tin trade to themselves, and for centuries they maintained the monopoly. Even the Gauls, the near neighbors of the Britons, were unacquainted with the riches of the Cassiterides. So carefully and prudently was the situation of the Tin Islands kept secret, that, in order that a rival nation should not become aware of a safe passage to them, a Phœnician ship, which was being pursued by the Romans, was purposely run upon the rocks by her captain. Compensation was made to the owners for the loss of the ship and her cargo by the Phœnician treasury. The diligent Greek historian Herodotus was unable to find out the real position of the Cassiterides, and only knew that they were beyond Gades. This is a proof not only of the advantages and profits derived from the trading in tin, but of the secrecy with which that trade was conducted. It seems uncertain how long the Phœnicians were masters of the situation, but it was probably during a period of about 300 to 400 years. At the end of this time the wearabouts of the Tin Islands were at last discovered by the other nations, and the Romans, Greeks and Gauls then came in to work the mines. The word "Melcarthus" is associated with the Phœnician discovery of Britain in writings of 1,000 years B. C., but it is doubtful whether it actually referred to the discovery of these islands or to a deity worshiped at Gades. Some writers are of opinion that the Phœnicians visited the Baltic for the purpose of obtaining amber, which is thrown up in quantity by the waters of that landlocked sea. It has further been suggested that they were searching for amber when they discovered the British Islands.

PREHISTORIC EUROPEAN ART.

IT is important to determine how far culture can independently arise in a given district, and how far it is dependent upon other centers of civilization. For many years M. Salomon Reinach has devoted himself to these problems, especially in reference to the culture of prehistoric Europe.

In his essays on "Le Mirage Orientale" he opposed the very prevalent idea that all our culture necessarily came from the East, and during the last three years he has contributed to L'Anthropologie a series of articles on "Sculpture in Europe before the Greco-Roman Influences." This long series of papers is concluded in the current number (No. 2, vol. vii) of that journal, and it forms a mine of information which cannot but prove of immense value to archæological students, especially as it is illustrated with four hundred and forty-one outline sketches culled from a vast array of authors. His general thesis comprises two arguments—the one negative, the other positive.

(1) M. Reinach tries to prove that the most primitive European artistic remains are far from justifying the view that the first models and tentative efforts came from Egypt or Babylon. One cannot trace any imitation of Assyrian cylinders or of Egyptian funeral figurines. The fauna figured by the rude artists of Europe is purely European; there is no lion, panther or camel. An apparently very grave difficulty occurs in the series of figures representing nude females, which authors agree in regarding as imitations of the Babylonian Astarte. M. Reinach argues that this type was indigenous, and so far from owing its existence to Babylonian influence, it, on the contrary, worked its way in all probability toward the valleys of the Euphrates and Tigris. He thinks that Europe (i. e., the Balkan Peninsula, the Archipelago, the Caucasus and the west coast of Asia Minor) only later, and to a restricted degree, became dependent upon the old civilizations of the Orient. In his opinion culture is polygamist. He admits multiple centers of creation for art, and refuses to believe that all illumination has come to us from the Euphrates and the Nile. He thinks that the Danube and the Rhine have some rights which should not be neglected, and that the future barbarians who dwelt along the borders of these rivers were not reduced to receive everything from without.

(2) M. Reinach recognizes that it is not sufficient to affirm that art can be born in diverse places and that the germ has not arisen from two or three privileged centers of the ancient world; and so he sets himself to show how the rudiment of art has been able to arise, even among peoples whose genius was for a long time in abeyance. To that purpose M. Reinach has "insisted on the evolution of the most simple decorative motives which, at a certain point, quite naturally suggested the idea of the human or animal form. In these not very numerous cases one can follow the transformations of a plastic motive down to the entirely geometric figure from which it arose. But the taste for geometric forms and the tendency to conventionalization (stylization), that is to say, to the purely decorative modification of organic lines, have been for long centuries so powerful in Europe that even foreign types have not escaped their petrifying action. A fortiori, the indigenous types, arisen from geometrical devices, have always been constrained to return back to them again. It is not denied that in Europe, as elsewhere, the imitation of surrounding nature has given origin to some plastic attempts; but there is proof that this inspiration drawn from nature has been feeble, even in the imitation of animal forms, which represented only a very small number of the animals known to the people."

The author admits that several statuettes figured in this memoir reflect outside influences, particularly of Italy, where Ionian art early took root. But these influences were not exercised in an immediate manner, and the indigenous style appears to have always been predominant, even when brought face to face with foreign objects. A similar phenomenon is noticeable in Italy itself, which was Hellenized very slowly, and was only partially Orientalized under the Roman empire.

Such is an outline of M. Reinach's position. There is no doubt that it will open up a wide discussion, as he covers a great deal of ground and deals with some matters which admit of diversity of opinion.

M. Reinach, in an earlier section of his memoir (L'Anth. v, 1894, p. 305), definitely states that "in the primitive art of Central Europe the geometric form (a triangle) has suggested the anthropomorphic form, and it is not the anthropomorphic figure which is degenerated into the geometric." Possibly some, at all events, of these flat plates had indications of features painted on their surface, and thus they may have been more realistic than now appears, and later they were made more human like as the fabricators became more skilled or as they valued greater realism.

The investigations of quite a number of men of science show that so-called "geometric" designs are often really highly conventionalized representations of natural objects, mainly of animals; others are suggestions of textiles or other handicrafts. Probably relatively few "geometric" designs are purely meaningless decorations. So far as available evidence goes, there are not many (if any) examples of the evolution of human or animal forms by "suggestion" from purely geometric designs, but the reverse process is extremely common.

Doubtless some of the problems involved in this memoir will be fully discussed at the forthcoming meeting of the British Association at Liverpool during the great discussion which has been arranged for on the culture and origins of the Mediterranean race. We understand that M. Reinach intends to be present on this occasion, when he will be able to state his views and reply to his critics.—Nature.

RELATIVE MOTION OF THE STARS IN THE LINE OF SIGHT.

THE determination of the motion of the stars in the line of sight by means of the spectroscope is one of the most important problems in astronomy. The greatest, and almost the only, objection to the objective prism is that it has thus far failed to determine this quantity. Placing the prism in front of the objective has many advantages over the use of a slit spectroscope. Instead of photographing one star at a time, more than a thousand have, in many instances, been photographed upon a single plate. In fact, our only knowledge of the photographic spectra of the fainter stars is derived from plates obtained with an objective prism. The wave lengths of the lines can also generally be determined equally well by either method, since in the spectrum of almost every star numerous lines are present whose wave lengths have already been accurately determined in the solar spectrum. The wave lengths of other lines can be better determined differentially from these than directly by a comparison spectrum. Nearly all of the Draper Memorial spectra have been photographed by means of objective prisms. Numerous unsuccessful attempts have been made here, ever since this work was undertaken, to determine with an objective prism the approach and recession of the stars. Among other methods which have been tried may be mentioned the use of an absorbing medium like didymium, the variation in length of the spectra, and the use of a point of reference formed by throwing an auxiliary image of the star into the field by means of a small achromatic prism, or by reflecting prisms. Recently experiments have been made by comparing the corresponding lines in the spectra of different stars with their images taken on another plate without the prism and with the film reversed. A discussion of this method by the writer with Mr. Edward S. King has led to the method described below, which promises to determine accurately the relative motion of two or more stars in the line of sight if they are near enough together to be photographed upon the same plate. Let A and B be two such stars, A being at rest and B approaching with such a velocity that a given line in its spectrum is deviated by the amount d, and let a photograph be taken in such a position that the end of

shorter wave length of the spectrum of B is turned toward that of A. Then the distance between the images of the given line in the two spectra will be less by the amount, d, than it would be if both stars were at rest. Now let another photograph be taken in which, by turning the prism 180°, the spectra are turned by the same amount, so that the end of greater wave length of the spectrum of B is turned toward that of A. The distance between the two lines will then be increased by an equal amount. If two such photographs are superposed and the images of the reference line in the spectra of A are made to coincide, its images in the spectra of B will deviate by 2d. To apply this method, a photograph of a region a little east of the meridian is taken in the usual way. Then the telescope is reversed and a second photograph of the same region is taken on a plate with the film side away from the star, so that the photograph is taken through the glass. As both photographs are taken near the meridian, the lines will be nearly perpendicular to the length of the spectrum, while, at a large hour angle, if the exposure is long, and the spectra narrow, the lines will cross them obliquely, owing to the differential refraction. Reversing the telescope turns the prisms, and with them the spectra exactly 180°. In making the examination the plates are placed film to film so that the spectra are side by side, and one is moved over the other by means of a micrometer screw. The corresponding lines in the two images of each star in turn are made to coincide, and the difference in the readings gives double the displacement of the line. An error in orienting the plates would affect the results when the stars compared are not in the same right ascension. This source of error may probably be made insensible in several ways, such as by marking a reference line on each plate, or by turning the prisms so that their edges are perpendicular to the line connecting the stars and moving the plate slowly by clockwork. Since the ends only of the lines are compared, narrow spectra may be used, and faint stars may therefore be measured. Experiments are now in progress with a cylindrical lens, by which it is expected that the accuracy of setting on lines in very narrow spectra can be still further increased.

Only preliminary tests of this method can be made at Cambridge at present, as our three best prisms are now in Peru. Two photographs of 101 and 102 Herculis were, however, taken on October 9, 1896, with a single prism, giving poor definition, but showed by inspection that the first of these stars was approaching more rapidly than the second. Measures by Mr. King of the lines $H\varepsilon$ and $H\zeta$ indicated the relative velocities 87 and 94 kilometers a second respectively. These results are not corrected for the position of the prism and other sources of instrumental error. The probable error as indicated by the accordance of the individual settings is 5 kilometers in each case. An inspection of two photographs of the Pleiades shows that the relative motions of the seven brightest stars in the group, although perhaps measurable, is not appreciable to the eye, and probably does not exceed 30 kilometers a second.

The advantages of the above method are, first, the directness of the determination of the motion; second, that double the deviation is measured; and third, that as the ends of two similar lines are made to coincide, the accidental errors of measurement are much less than when each in turn is bisected by a spider line. Since each line in the spectrum may be used, a large number of independent determinations may be obtained from one pair of plates. On the other hand, as it is only necessary that one line should be in focus, a visual telescope may be employed; that is, one uncorrected for the photographic rays. No corrections need be applied for the motion of the sun in space or of the earth in its orbit, since they will affect both stars equally.

Edward C. Pickering.

Harvard College Observatory.

SIR BENJAMIN WARD RICHARDSON, M.D., LL.D., F.R.S.

Sir Benjamin Ward Richardson was born at Somerby, in Leicestershire, on the 31st October, 1828. He received his early education at the school of the Rev. W. T. Nutt, at Burrow-on-the-Hill, in the same county, afterward proceeding to the Andersonian University at Glasgow, and graduating at St. Andrew's in 1854. In the same year he gained the Fothergilian medal for an essay on the diseases of the child before birth, and the Astley Cooper prize of £300 for an essay on the coagulation of the blood. In 1855 he originated the Journal of Health, later the Social Science Review, which he conducted for several years. He became in 1856 a member by examination of the Royal College of Physicians.

In 1865 he commenced a series of experiments in practical physiology, in order to ascertain the nature of the poisons in contagious diseases, which resulted in the detection of a special poisonous product common to them all, which he named septine. In the following year he introduced the use of ether spray to alleviate the local pain in surgical operations. Later he also introduced the use of methylene bichloride in similar cases.

In 1873 he announced the result of experiments which added greatly to our knowledge of the phenomenon of muscular irritability. The subjects brought under consideration were (1) the effect of cold on muscular irritability after systemic death; (2) the effect of motor forces; (3) the effect of abstracting or supplying blood; and (4) the effect of certain chemical agents, organic or inorganic. The researches were fully detailed in the Croonian lecture delivered by Dr. Richardson in 1873. In 1875, at the Social Science Congress held at Brighton, Dr. Richardson delivered an address, afterward published, entitled "Hygeia: a City of Health," giving a description of a city perfect in all its sanitary arrangements. The book attracted great attention, and an attempt was made to promote a model city on this basis. A site was secured near Worthing, but the enormous expense of the scheme led to its early abandonment.

During the agitation against vivisection, Dr. Richardson rendered great service to the cause of the experimental physiologist by his evidence, showing the many valuable discoveries leading to the prevention or alleviation of disease which could not have been accomplished without the aid of experimentation on animals. Among other important discoveries, he claimed as the result of vivisection or similar processes the deposition of fibrine in the heart, and the means by which it may be checked; the properties of ether spray and various anæsthetics; various means of restoring suspended animation; the operation of tracheotomy in diphtheria; the influence of nitrite of amyl on the nervous system; and the operations for cataract.

Besides being a skillful physiologist and a great sanitary reformer, Dr. Richardson was well known as a leader among men of science in the great temperance movement, in the interests of which he has written several essays and pamphlets. Sir Benjamin was stricken with apoplexy and never rallied, dying on November 21. Many of his articles have been printed in the Supplement.

THE LATE SIR BENJAMIN WARD RICHARDSON.

Contributions to a Knowledge of the Rancidification of Fats.—Ed. Spaeth.—The author sums up the results of his experiments as follows: I. In the rancidification of fats (hog's lard), which must be regarded as a process of oxidation chiefly occasioned by the action of light and of atmospheric oxygen, the unsaturated body acids (oleic acid) are chiefly attacked with the formation of acids with a low percentage of carbon. There is also a formation of aldehydic bodies and of oxy-fatty acids. II. With the progress of oxidation and the formation of free acids the volatile acids undergo a very great increment. III. All the acids participate in the formation of the free fatty acids. IV. With the increasing oxidation of the fats, their absorptive power, as well as the iodine number, undergoes a corresponding decrease, which diminution is effected by an oxidation and decomposition of the non-saturated fatty acids and by their polymerization. Such oxidized fats exhibit in the refractometer a decidedly higher deflection than do normal fats. The increase in the deflection is decidedly due to polymerization of the non-saturated fatty acids. V. Fats which have become rancid have in general a higher melting point than recent fats.—Zeit. Anal. Chem.

PRESERVATION OF COLOR IN MUSEUM SPECIMENS.

Curators of pathological museums have made numerous attempts to obtain a preservative fluid which will enable the original color to be retained by the specimens, but hitherto only indifferent success has rewarded their efforts. Especially has this been the case with the lungs and brain. In the Berliner Klinische Wochenschrift of August 31, a paper is published by Dr. C. Kaiserling describing a process he has introduced, and with very encouraging results. The organ to be preserved is first placed in a solution of the following composition: Formalin, 750 c. cm.; distilled water, 1000 c. cm.; nitrate of potash, 10 grammes; acetate of potash, 30 grammes. The organ is disposed in such a position as to preserve its form as far as possible, and the fluid should be large in proportion to the size of the specimen. This solution does not abstract any color, but remains quite clear, and can be used for a large number of specimens. An immersion of twenty-four hours in the fluid is sufficient for any tissue, but double this period will not do any harm. The organ is then allowed to lie for twelve hours in 80 per cent. alcohol and then for two hours in 95 per cent., and is subsequently preserved in equal parts of water and glycerine, with the addition of thirty parts of acetate of potash. Very delicate tissues, such as intestine, are best kept in equal quantities of glycerine and water after the addition of absolute alcohol in the proportion of one part of alcohol to ten of the mixture. By this method Dr. Kaiserling has succeeded in retaining the natural color of blood (congestion, infarcts, etc.), and the transparency of nearly all organs. The substance of the brain is particularly well preserved, areas of softening, hemorrhages, and pus in the pia mater being very well demonstrated. Excellent specimens were also obtained of lung, liver, and kidneys. Nodules of tubercle with central caseation exhibited both zones clearly delineated. Cysts in the kidney remained unaltered, retaining the color of their contents, and areas of fatty metamorphosis were seen of a yellow color. Intestinal ulceration, tubercles in the pleura, red and white marrow, and the muscles, all retained a fresh and natural appearance. If this process should prove a permanent one, it will add very greatly to the value of our museum specimens.

TESTS OF EXPLODED CYLINDERS FOR COMPRESSED HYDROGEN GAS.*

At the instance of the Royal Balloon Corps, tests of the materials of a number of iron cylinders for containing hydrogen gas were made; a number of cylinders having been destroyed by an explosion, the cause of which has not been discovered.

A number of complete cylinders and of single pieces were selected by the author for experiment. The selected pieces were immediately marked with the letters M, R, and E, according to the group from which they were selected. There was selected from each group a cylinder which had been deformed but not broken by the explosion, broken pieces from the top and bottom ends of a cylinder, and a few broken pieces which appeared to have remarkable fractures.

The method of preparing the test pieces, and their positions in the cylinders, is described. Tension and bending tests were made, and some test pieces drawn out under the hammer.

Chemical analyses were made by the Chemical Technical Institution. A microscopic examination was made, and a number of reproductions were made by means of the micro photographic apparatus.† The results of the tension and bending tests are given in tabular form.

From the analyses, the percentage of carbon in the materials R, M, and E is 0·38, 0·26, and 0·17 respectively. The appearance of the specimens under the microscope is discussed.

The tests show that the cylinders M have been made from a material which had not been mechanically worked at a low heat, since the tension tests on the material as received and on annealed specimens do not differ essentially. The elastic limit of the material as received is higher than that of the annealed specimens, but this may be due to the fact that the hydraulic tests produced a slight set, and therefore raised the elastic limit. The tests on specimens hardened in water show that the material can be hardened, the breaking stress rising from 41·1 to 53·4 tons per square inch. The extension on fracture with the hardened specimens was very small.

The experiments showed that the material of the cylinders R was fairly hard steel. The tenacity fell considerably on hardening in water, and it is feared that the material had been deteriorated during manufacture.

The cylinders E were made from wrought iron, which the chemical analysis shows was very pure. The material gains in strength by cooling in water, but loses the greater part of its ductility, though not to the same degree as the material M and R.

The Testing Institution recommends that during the manufacture of the cylinders they should be so marked that the inspector should be able to identify all cylinders produced from the same smelting. From each smelting, two test pieces for bending and two test pieces

* By Prof. A. Martens, Mittheilungen aus den königlichen technischen Versuchsanstalten zu Berlin, 1896, p. 1. Foreign Abstracts, Proc. Inst. C.E.

† Mittheilungen aus den königlichen technischen Versuchsanstalten, 1891, p. 278.

for drawing out under the hammer should be taken. Of every hundred complete cylinders, two should be submitted to a hydraulic test until a permanent increase of circumference lying between 0·5 millimeter and 1·5 millimeter is produced. The cylinders should be subjected to a water pressure of 1·1 n without suffering any change of form; n being the pressure which, after filling under normal conditions, can be produced by exposing the cylinders to the sun. A number of details as to the preparation of the test pieces is given.

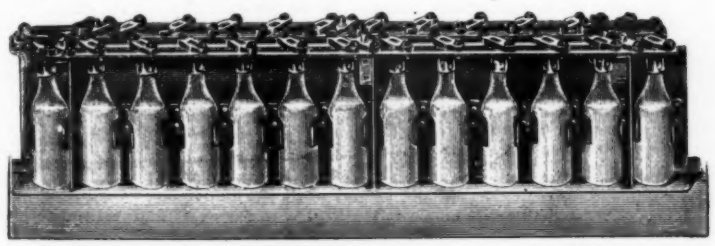
To the question as to what specification the material should be made to, it is recommended that only the stresses on the yield point and the extension and fracture should be specified, and that a premium should be placed on a high extension. A stress at the yield point lying between 22 tons and 28 tons per square inch and an extension of 10 per cent. might be accepted.

The question as to whether these cylinders might possibly have been injured by the hydraulic test is answered in the negative.—The Practical Engineer.

THE DAIRY SHOW.

THE twenty-first annual exhibition promoted by the British Dairy Farmers' Association, of which the Prince of Wales is patron and the Earl of Powis president, was opened recently at the Agricultural Hall, Islington. The entries are 1,433 more than those of last year, making by far the largest total ever attained. The exhibits fill, not only the ground floor and the galleries, but also two large annexes, now used for the first time for the purposes of the Dairy Show.

One cannot fail to be struck by the unusually large amount of attention which is now being paid to provide apparatus for supplying milk free from germs and capable of being kept for an indefinite period. From this point of view the most attractive exhibits in the



BOTTLE HOLDER.

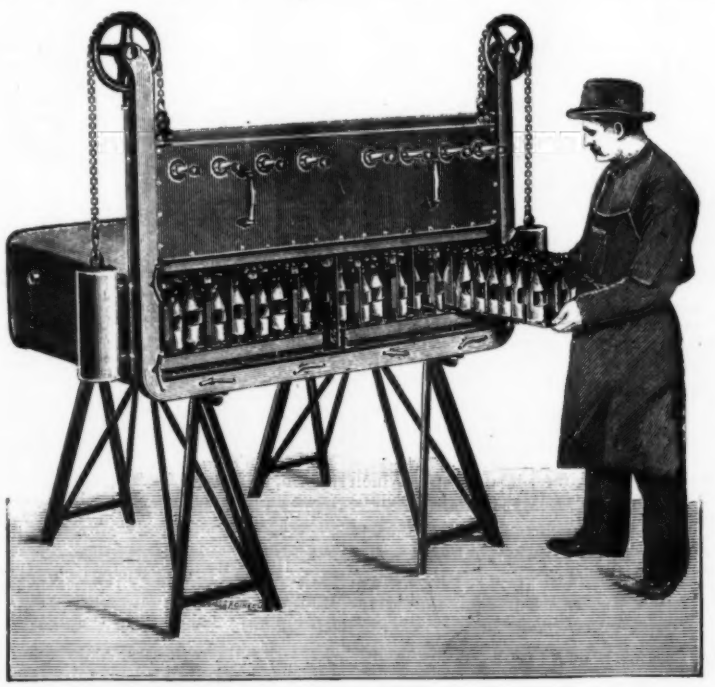
show are those shown by Dr. Gustav Schack-Sommer, of Upper Woburn Place, London, W. C. On this stand are two forms of apparatus for sterilizing milk, one for its treatment in bulk, and the other for producing the desired results in bottles, both of which are due to the inventive genius of Messrs. Popp and Becker. The former of these consists of a heater, a sterilizer proper, and a cooler.

This new procedure utilizes to the utmost extent the sterilizing action of steam. The live steam, at high pressure, is led into the milk at boiling point, and coming thus into immediate contact with the milk, kills all the bacteria and germs suspended in it. The destructive action is still further assured, as by this process the temperature can be raised much over 212° Fah. without any fear of the milk being "burnt." The entrance of the steam causes such an ebullition that any adhesion of the milk to the sides of the vessel is an impossibility, and by a special arrangement of the apparatus, which keeps the milk above the boiling temperature of the water, it is impossible for any condensation of the steam to take place, and thereby cause a thinning of the milk. The steam makes its exit through a pipe fixed in the cover of the apparatus, and with it escape the malodorous gases contained in the milk. In the heater the milk is warmed to boiling point and then flows into the sterilizer. During the progress of the sterilization a second quantity of milk is being warmed in the heater, in readiness to replace the first, when that passes into the cooler. The heater is thus liberated for a third charge. In this manner, an uninterrupted, time saving operation is achieved.

In order to carry out the purification process to its utmost limits, there is combined with the apparatus an appliance for sterilizing and filling the milk cans. The stand on which the cans are placed revolves on a hollow axis through which steam or milk, as required, is admitted to them. For the purpose of sterilizing the empty cans, the mechanism is so arranged that the cans are turned upside down to allow of the water of condensation, which results from the steam passing through them, to escape. When this steaming out has been accomplished, the stand, and with it the cans, is reversed. A two-way cock, which is fixed near the end of the cans, is put in such a position that the air which is drawn into the cans, consequent upon cooling down, has to pass through an air filter which retains the bacteria, thereby maintaining the sterile condition of the cans. The sterilized and cooled milk is then allowed to flow through the same hollow axis through which the steam had previously passed, and so enters the cans without being contaminated.

RUBBER STOPPER WITH GLASS PLUG.

The apparatus for treating the milk—or any other food stuff—in bottles also depends for its action upon the properties of steam at a high temperature, and consists of a sterilizing chamber, provided with rails, to carry a series of frames for holding the bottles. This apparatus is shown in the accompanying illustrations. A steam inlet valve, a safety valve, and exhaust valve are also provided, and the whole is rendered steam tight by a vertically sliding door with counterweights. An essential feature of the apparatus is the arrangement of stopping the bottles. This is a double arrangement, consisting of an India rubber stopper in which is placed a glass plug. The latter has a groove, which in a certain position affords communication between the atmosphere and the contents of the bottles, but which when turned absolutely seals the interior from contact with the atmosphere. When steam has been admitted to the sterilizing chamber, and hence to the contents of the bottles, for the necessary length of time, the whole of the glass plugs are turned in their rubber stoppers by means of strikers placed conveniently without the chamber, thereby effectually sealing the bottles, which can then be removed. As the contents of the bottles cool down a vacuum is formed in the usual manner, and the liquid continues to boil for a considerable time.—Engineer.



MILK STERILIZER.

[Continued from SUPPLEMENT, No. 1091, page 17433.]

THE BRITISH ASSOCIATION—ANTHROPOLOGY.*

THE prevalence of the spiral ornamentation on stone work in the Ægean islands and contemporary Egypt, was it merely to be regarded as a coincidence? To turn one's eye to the Nile valley, was it simply another instance of the "Mirage Orientale"? For my own part, I ventured to believe that, as in the case of northern Europe, the spread of this system was connected with many collateral symptoms of commercial inter-connection, so here, too, the appearance of this early Ægean ornament would be found to lead to the demonstration of a direct intercourse between the Greek islands and Egypt at least a thousand years earlier than any that had hitherto been allowed.

One's thoughts naturally turned to Crete, the central island, with one face on the Libyan Sea—the natural source and seminary of Ægean culture—where fresh light was already being thrown on the Mycenæan civilization by the researches of Prof. Halbherr, but the earlier prehistoric remains of which were still unexplored. Nor were these expectations unfounded. As the result of three expeditions—undertaken in three successive years, from the last of which I returned three months since—it has been my fortune to collect a series of evidences of a very early and intimate contact with Egypt, going back at least to the Twelfth Dynasty, and to the earlier half of the third millennium before our era. It is not only that in primitive deposits, like that of Hagios Onuphrios, scarabs, acknowledged by competent archæologists to be of Twelfth Dynasty date, occurred in association with steatite seals presenting the Ægæan spiral ornamentation, and with early pottery answering to that of Amorgos and the second city of Troy. This by itself might be regarded by many as convincing. But—what from the point of view of intercourse and chronology is even more important—in the same deposit and elsewhere occurred early button-shaped and triangular seals of steatite with undoubted indigenous copies of Egyptian lotos designs characteristic of the same period, while in the case of the three-sided bead seals it was possible to trace a regular evolution leading down to Mycenæan times. Nor was this all. Throughout the whole of the island there came to light a great variety of primitive stone vases, mostly of steatite, a large proportion of which reproduced the characteristic forms of Egyptian stone vases, in harder materials, going far back into the Ancient Empire. The returning spiral motive is also associated with these, as may be seen from a specimen now in the collection of Dr. Naue, of Munich.

A geological phenomenon which I was able to ascertain in the course of my recent exploration of the eastern part of the island goes far to explain the great importance which these steatite or "soapstone" fabrics played in the primitive culture of Crete and the Ægean islands. In the valley of the Sarakina stream I came upon vast deposits of this material, the diffusion of which could be further traced along a considerable tract of the southern coast. The abundant presence of this attractive and, at the same time, easily workable stone—then incomparably more valuable, owing to the imperfection of the potter's art—goes far to explain the extent to which these ancient Egyptian forms were imitated, and the consequent spread of the returning spiral motive throughout the Ægean.

In the matter of the spiral motive, Crete may thus be said to be the missing link between prehistoric Ireland and Scandinavia and the Egypt of the Ancient Empire. But the early remains of the island illustrate in many other ways the comparatively high level of culture already reached by the Ægean population in præ-Mycenæan times. Especially are they valuable in supplying the antecedent stages to many characteristic elements of the succeeding Mycenæan civilization.

This ancestral relationship is nowhere more clearly traceable than in a class of relics which bear out the ancient claim of the islanders that they themselves had invented a system of writing to which the Phœnicians did not do more than add the finishing touches. Already, at the Oxford meeting of the association, I was able to call attention to the evidence of the existence of a prehistoric Cretan script evolved by gradual simplification and selection from an earlier picture writing. This earlier stage is, roughly speaking, illustrated by a series of primitive seals belonging to the "Period of Amorgos." In the succeeding Mycenæan age the script is more conventionalized, often linear, and though developments of the earlier forms of seals are frequently found, they are usually of harder materials, and the system is applied to other objects. As the result of my most recent investigations, I am now able to announce the discovery of an inscribed prehistoric relic, which surpasses in interest and importance all hitherto known objects of this class. It consists of a fragment of what may be described as a steatite "Table of Offerings," bearing part of what appears to be a dedication of nine letters of probably syllabic values, answering to the same early Cretan script that is seen on the seals, and with two punctuations. It was obtained from the lowest level of a Mycenæan stratum, containing numerous votive objects, in the great cave of Mount Dikta, which, according to the Greek legend, was the birthplace of Zeus.

This early Cretan script, which precedes by centuries the most ancient records of Phœnician writing, and supplies, at any rate, very close analogies to what may be supposed to have been the pictorial prototypes of several of the Phœnician letters, stands in a direct relation to the syllabic characters used at a later date by the Greeks of Cyprus. The great step in the history of writing implied by the evolution of symbols of phonetic value from primitive pictographs is thus shown to have effected itself on European soil.

In many other ways the culture of Mycenæ—that extraordinary revelation from the soil of prehistoric Greece—can be shown to be rooted in this earlier Ægean stratum. The spiral system, still seen in much of its

* Opening address by Arthur J. Evans, President of Section H, and published in Nature.

pure original form on gold vessels and ornaments from the earlier shaft graves of Mycenæ, is simply the translation into metal of the pre-existing steatite decoration. (See Hellenic Journal, xii, 1892, p. 221.)

The Mycenæan répoussé work in its most developed stage as applied to human and animal subjects has probably the same origin in stone work. Cretan examples, indeed, give the actual transition in which an intaglio in dark steatite is coated with a thin gold plate impressed into the design. On the other hand, the noblest of all creations of the Mycenæan goldsmith's art, the Vaphio cups, with their bold reliefs, illustrating the hunting and capture of wild bulls, find their nearest analogy in a fragment of a cup, procured by me from Knôsos, of black Cretan steatite, with naturalistic reliefs, exhibiting a fig tree in a sacred inclosure, an altar, and men in high action, which in all probability was originally coated, like the intaglio, with thin plates of gold.

In view of some still prevalent theories as to the origin of Mycenæan art, it is important to bear in mind these analogies and connections, which show how deeply set its roots are in Ægean soil. The Vaphio cups, especially, from their superior art, have been widely regarded as of exotic fabric. That the art of a European population in prehistoric times should have risen above that of contemporary Egypt and Babylonia was something beyond the comprehension of the traditional school. These most characteristic products of indigenous skill, with their spirited representations of a sport the traditional home of which in later times was the Thessalian plains, have been, therefore, brought from "Northern Syria"! Yet a whole series of Mycenæan gems exists executed in the same bold naturalistic style, and of local materials, such as lapis Lacedæmonius, the subjects of which are drawn from the same artistic cycle as those of the cups, and not one of these has as yet been found on the Eastern Mediterranean shores. Like the other kindred intaglios, they all come from the Peloponnese, from Crete, from the shores and islands of the Ægean, from the area, that is, where their materials were procured. The lentoid and almond shaped forms are altogether foreign to Semitic usage, which clung to the cylinder and cone. The finer products of the Mycenæan glyptic art on harder materials were, in fact, the outcome of long apprentice studies of the earlier Ægean population, of which we have now the record in the primitive Cretan seals, and the explanation in the vast beds of such an easily worked material as steatite.

But the importation of the most characteristic Mycenæan products from "Northern Syria" has become quite a moderate proposition beside that which we have now before us. In a recent communication to the French Academy of Inscriptions, Dr. Helbig has reintroduced to us a more familiar figure. Driven from his prehistoric haunts on the Atlantic coasts, torn from the Cassiterides, dislodged even from his Thucididean plantations in pre-Hellenic Sicily, the Phœnician has returned, tricked out as the true "Mycenæan."

A great part of Dr. Helbig's argument has been answered by anticipation. Regardless of the existence of a regular succession of intermediate glyptic types, such as the "Melian" gems and the engraved seals of the geometrical deposits of the Greek mainland, like those of Olympia and of the Heræon at Argos, which link the Mycenæan with the classical series, Dr. Helbig takes a verse of Homer to hang from it a theory that seals and engraved stones were unknown to the early Greeks. On this imaginary fact he builds the astounding statement that the engraved gems and seals found with Mycenæan remains must be of foregin and, as he believes, Phœnician importation. The stray diffusion of one or two examples of Mycenæan pots to the coast of Palestine, the partial resemblance of some Hittite bronze figures, executed in a more barbarous Syrian style, to specimens of quite different fabric found at Tiryns, Mycenæ, and, it may be added, in a Cretan cave near Sybrita, the wholly unwarranted attribution to Phœnicia of a bronze vase handle found in Cyprus, exhibiting the typical lion headed demons of the Mycenæans—these are only a few salient examples of the reasoning by which the whole prehistoric civilization of the Greek world, so instinct with naturalism and individuality, is handed over to the least original member of the Semitic race. The absence in historic Greece of such arts as that of intarsia in metal work, of glass making (if true) and of porcelain making, is used as a conclusive argument against their practice by an Ægean population, of uncertain stock, a thousand years earlier, as if in the intervening dark ages between the primitive civilization of the Greek lands and the Classical Renaissance no arts could have been lost.

Finally, the merchants of Keftô depicted on the Egyptian monuments are once more claimed as Phœnicians, and with them—though this is by no means a necessary conclusion, even from the premise—the precious gifts they bear, including vases of characteristic Mycenæan form and ornament. All this is diametrically opposed to the conclusions of the most careful inquirer into the origins of this mysterious people, Dr. W. Max Müller (to be distinguished from the eminent professor), who shows that the list of countries in which Keftô occurs places them beyond the limit of Phœnicia or of any Semitic country, and connects them rather with Cilicia and with Cyprus, the scene, as we now know, of important Mycenæan plantations. It is certain that not only do the Keftiu traders bear articles of Mycenæan fabric, but their costume, which is wholly un-Semitic, their leggins and sandals, and the long double locks of hair streaming down below their armpits, identify them with the men of the frescoes of Mycenæ, and of the Vaphio and Knôsian cups.

The truth is that these Syrian and Phœnician theories are largely to be traced to the inability to understand the extent to which the primitive inhabitants of the Ægean shores had been able to assimilate exotic arts without losing their own individuality. The precocious offspring of our continent, first come to man's estate in the Ægean island world, had acquired cosmopolitan tastes, and already stretched forth his hands to pluck the fruit of knowledge from Oriental boughs. He had adopted foreign fashions of dress and ornament. His artists reveled in lion hunts and palm trees. His very worship was infected by the creations of foreign religions.

The great extent to which the Mycenæans had assimilated exotic arts and ideas can only be understood when it is realized that this adaptive process had begun at least a thousand years before, in the earlier period of Ægean culture. Now impulses from Egypt and Chaldæa now succeed the old. The connection with Eighteenth and Nineteenth Dynasty Egypt was of so intimate a kind that it can only be explained by actual settlement from the Ægean side. The abundant relics of Ægean ceramic manufactures found by Prof. Petrie on Egyptian sites fully bear out this presumption. The early marks on potsherds discovered by that explorer seem to carry the connection back to the earlier Ægean period, but the painted pottery belongs to what may broadly be described as Mycenæan times. The earliest relics of this kind found in the rubbish heaps of Kahun, though it can hardly be admitted that they go quite so far back as the Twelfth Dynasty date assigned to them by Mr. Petrie (c. 2500 B. C.), yet correspond with the earliest Mycenæan classes found at Thera and Tiryns, and seem to find their nearest parallels in pottery of the same character from the cave of Kamares on the northern steep of the Cretan Ida, recently described by Mr. J. L. Myres and by Dr. Lucio Mariani. Vases of the more typical Mycenæan class have been found by Mr. Petrie in a series of deposits dated, from the associated Egyptian relics, from the reign of Thothmes III onward (1450 B. C.) There is nothing Phœnician about these—with their seaweeds and marine creatures they are the true products of the island world of Greece. The counterpart to these Mycenæan imports in Egypt is seen in the purely Egyptian designs which now invade the northern shores of the Ægean, such as the ceiling of the sepulchral chamber at Orchomenos, or the wall paintings of the palace at Tiryns—almost exact copies of the ceilings of the Theban tombs—designs distinguished by the later Egyptian combination of the spiral and plant ornament which at this period supersedes the pure returning spiral of the earlier dynasties. The same contemporary evidence of date is seen in the scarabs and porcelain fragments with the cartouches of Queen Tyi and Amenhotep III, found in the Mycenæan deposits. But more than a mere commercial connection between the Ægean seat of Mycenæan culture and Egypt seems to be indicated by some of the inlaid daggers from the acropolis tombs. The subject of that representing the ichneumons hunting ducks amid the lotos thickets beside a stream that can only be the Nile, as much of the intarsia technique, is so purely of Egypt that it can only have been executed by a Mycenæan artificer resident within its borders. The whole cycle of Egyptian Nile pieces thoroughly penetrated Mycenæan art—the duck catcher in his Nile boat, the water fowl and butterflies among the river plants, the spotted cows and calves, supplied fertile motives for the Mycenæan goldsmiths and ceramic artists. The griffins of Mycenæ reproduce an elegant creation of the New Empire, in which an influence from the Asiatic side is also traceable.

The assimilation of Babylonian elements was equally extensive. It too, as we have seen, had begun in the earlier Ægean period, and the religious influence from the Semitic side, of which traces are already seen in the assimilation of the more primitive "idols" to Eastern models, now forms a singular blend with the Egyptian, as regards, at least, the externals of cult. We see priests, in long folding robes of Asiatic cut, leading griffins, offering doves, holding axes of a type of Egyptian derivation which seems to have been common to the Syrian coast, the Hittite regions of Anatolia, and Mycenæan Greece. Female votaries in flounced Babylonian dresses stand before seated goddesses, rays suggesting those of Shamas shoot from a sun god's shoulders, conjoined figures of moon and star recall the symbols of Sin and Istar, and the worship of a divine pair of male and female divinities is widely traceable, reproducing the relations of a Semitic Bel and Beltis. The cylinder subjects of Chaldean art continually assert themselves: a Mycenæan hero steps into the place of Gilgames or Eabani, and renews their struggles with wild beasts and demons in the same conventional attitudes, of which Christian art has preserved a reminiscence in its early type of Daniel in the lions' den. The peculiar schemes resulting from or, at least, brought into continual prominence by the special conditions of cylinder engraving, with the constant tendency to which it is liable of the two ends of the design to overlap, deeply influenced the glyptic style of Mycenæ. Here, too, we see the same animals with crossed bodies, with two bodies and a single head, or simply confronted. These latter affiliations to Babylonian prototypes have a very important bearing on many later offshoots of European culture. The tradition of these heraldic groups preserved by the later Mycenæan art, and communicated by it to the so-called "Oriental" style of Greece, finds in another direction its unbroken continuity in ornamental products of the Hallstatt province, and that of the late Celtic metal workers.

"But this," exclaims a friendly critic, "is the old heresy—the 'Mirage Orientale,' over again. Such heraldic combinations have originated independently elsewhere. Why may they not be of indigenous origin in primitive Europe?"

They certainly may be. Confronted figures occur already in the Dordogne caves. But, in a variety of instances, the historic and geographical connection of these types with the Mycenæan, and those in turn with the Oriental, is clearly made out. That system which leaves the least call on human efforts at inventiveness seems in anthropology to be the safest.

Let us then fully acknowledge the indebtedness of early Ægean culture to the older civilizations of the east. But this indebtedness must not be allowed to obscure the fact that what was borrowed was also assimilated. On the easternmost coast of the Mediterranean, as in Egypt, it is not in a pauper's guise that the Mycenæan element makes its appearance. It is rather the invasion of a conquering and superior culture. It has already outstripped its instructors. In Cyprus, which had lagged behind the Ægean peoples in the race of progress, the Mycenæan relics make their appearance as imported objects of far superior fabric, side by side with the rude insular products. The final engrafting on Cypriote soil of what may be called a colonial plantation of Mycenæ later reacts on Assyrian art, and justifies the bold theory of Prof. Brunn that the sculptures of Nineveh betray Greek handiwork. The concordant Hebrew tradition that the Philistines were immigrants from the Islands of the Sea, the name "Cherethim," or Cretans, actually applied to them, and the religious ties which attached "Minoan" Gaza to the cult of the Cretan Zeus are so many indications that the Ægean settlements, which in all probability existed in the Delta, extended to the neighboring coast of Canaan, and that among other towns the great staple of the Red Sea trade had passed into the hands of these prehistoric Vikings. The influence of the Mycenæans on the later Phœnicians is abundantly illustrated in their eclectic art. The Cretan evidence tends to show that even the origins of their alphabet receive illustration from the earlier Ægean pictography. It is not the Mycenæans who are Phœnicians. It is the Phœnicians who, in many respects, acted as the depositaries of decadent Mycenæan art.

If there is one thing more characteristic than another of Phœnician art, it is its borrowed nature and its incongruous collocation of foreign elements. Dr. Helbig himself admits that if Mycenæan art is to be regarded as the older Phœnician, the Phœnician historically known to us must have changed its nature. What the Mycenæans took they made their own. They borrowed from the designs of Babylonian cylinders, but they adapted them to gems and seals of their own fashion, and rejected the cylinders themselves. The influence of Oriental religious types is traceable on their signet rings, but the liveliness of treatment and the dramatic action introduced into the groups separate them, toto cælo, from the conventional schematism of Babylonian cult scenes. The older element, the sacred trees and pillars which appear as the background of these scenes—on this I hope to say more later on in this section—there is no reason to regard here as Semitic. It belongs to a religious stage widely represented on primitive European soil, and nowhere more persistent than in the West.

Mycenæan culture was permeated by Oriental elements, but never subdued by them. This independent quality would alone be sufficient to fix its original birthplace in an area removed from immediate contiguity with that of the older civilizations of Egypt and Babylonia. The Ægean island world answers admirably to the conditions of the case. It is near, yet sufficiently removed, combining maritime access with insular security. We see the difference if we compare the civilization of the Hittites of Anatolia and Northern Syria, in some respects so closely parallel with that of Mycenæ. The native elements were there cramped and trammeled from the beginning by the Oriental contact. No real life and freedom of expression was ever reached; the art is stiff, conventional, becoming more and more Asiatic, till finally crushed out by Assyrian conquest. It is the same with the Phœnicians. But in prehistoric Greece the indigenous element was able to hold its own, and to recast what it took from others in an original mould. Throughout its handiwork there breathes the European spirit of individuality and freedom. Prof. Petrie's discoveries at Tell-el-Amarna show the contact of this Ægean element for a moment infusing naturalism and life into the time-honored conventionalities of Egypt itself.

A variety of evidence, moreover, tends to show that during the Mycenæan period the earlier Ægean stock was reinforced by new race elements coming from north and west. The appearance of the primitive fiddle bow shaped fibula or safety pin brings Mycenæan Greece into a suggestive relation with the Danube Valley and the Terremare of Northern Italy. Certain ceramic forms show the same affinities; and it may be noted that the peculiar "two storied" structure of the "Villanova" type of urn which characterizes the earliest Iron Age deposits of Italy finds already a close counterpart in a vessel from an acropolis grave at Mycenæ—a parallelism which may point to a common Illyrian source. The painted pottery of the Mycenæans itself, with its polychrome designs, betrays Northern and Western affinities of a very early character, though the glaze and exquisite technique were doubtless elaborated in the Ægean shores. Examples of spiraliform painted designs on pottery going back to the borders of the Neolithic period have been found in Hungary and Bosnia. In the early rock tombs of Sicily of the period anterior to that marked by imported products of the fully developed Mycenæan culture are found unglazed painted wares of considerable brilliancy, and allied classes recur in the heel of Italy and in the cave deposits of Liguria of the period transitional between the use of stone and metal. "The household gods," if so we may call them, of the Mycenæans also break away from the tradition of the marble Ægean forms. We recognize the coming to the fore again of primitive European clay types in a more advanced technique. Here, too, the range of comparison takes us to the same Northern and Western area. Here, too, in Sicily and Liguria, we see the primitive art of ceramic painting already applied to these at the close of the Stone Age. A rude female clay figure found in the Arene Candide cave near Finalmarina, the upper part of the body of which, armless and rounded, is painted with brown stripes on a pale rose ground, seems to me to stand in a closer relation to the prototype of a well known Mycenæan class than any known example. A small painted image, with punctuated cross bands over the breast, from a sepulchral grotto at Villafrati, near Palermo, belongs to the same early family as the bucchero types of Butmir, in Bosnia. Unquestionable parallels to the Mycenæan class have been found in early graves in Servia, of which an example copied by me some years since in the museum at Belgrade was found near the site of that later emporium of the Balkan trade, Viminacium, together with a cup attesting the survival of the primitive Ægean spirals. These extensive Italian and Illyrian comparisons, which find, perhaps, their converging point in the northwestern corner of the Balkan peninsula, show, at least approximately, the direction from which this new European impulse reached the Ægean shores.

It is an alluring supposition that this Northwestern infusion may connect itself with the spread of the Greek race in the Ægean islands and the southern part of the Balkan peninsula. There seems, at least, to be a reasonable presumption in favor of this view. The Mycenæan tradition, which underlies so much of the classical Greek art, is alone sufficient to show that a Greek element was at least included in the Mycenæan area of culture. Recent criticism has found in the Mycenæan remains the best parallel to much of the early arts and industries recorded by the Homeric poems. The megaron of the palaces at Tiryns and Mycenæ is the hall of Odysseus; the inlaid metal work of the shield of Achilles recalls the Egypto-Mycenæan intarsia of the dagger blades; the cup of Nestor with the feeding

doves, the subjects of the ornamental design. The siege piece, the lion hunt, the hound with its quivering quarry—all find their parallels in the works of the Mycenæan goldsmiths. The brilliant researches of Dr. Reichel may be said to have resulted in the definite identification of the Homeric body-shield with the most typical Mycenæan form, and have found in the same source the true explanation of the greaves and other arms and accouterments of the epic heroes.

That a Greek population shared in the civilization of Mycenæ cannot reasonably be denied, but that is far from saying that this was necessarily the only element, or even the dominant element. Archæological comparisons, the evidence of geographical names and consistent tradition, tend to show that a kindred race, represented later by the Phrygians on the Anatolian side, the race of Pelops and Tantalos, the special votaries of Kybêle, played a leading part. In Crete a non-Hellenic element, the Eteocretes, or "true Cretans," the race of Minôs, whose name is bound up with the earliest sea empire of the Ægean, and perhaps identical with that of the Minyans of Continental Greece, preserved their own language and nationality to the borders of the classical period. The Labyrinth itself, the double headed ax as a symbol of the divinity called Zeus by the Greek settlers, the common forms in the characters of the indigenous script, local names and historical traditions, further connect these Mycenæan aborigines of Crete with the primitive population, it, too, of European extraction, in Caria and Pisidia, and with the older elements in Lycia.

It is difficult to exaggerate the part played in this widely ramifying Mycenæan culture on later European arts from prehistoric times onward. Beyond the limits of its original seats, primitive Greece and its islands, and the colonial plantations thrown out by it to the west coast of Asia Minor to Cyprus, and in all probability to Egypt and the Syrian coast, we can trace the direct diffusion of Mycenæan products, notably the ceramic wares, across the Danube to Transylvania and Moldavia. In the early cemeteries of the Caucasus the fibulas and other objects indicate a late Mycenæan source, though they are here blended with allied elements of a more Danubian character. The Mycenæan impress is very strong in Southern Italy, and, to take a single instance, the prevailing sword type of that region is of Mycenæan origin. Along the western Adriatic coast the same influence is traceable to a very late date in the sepulchral stelæ of Pesaro and the tympanum relief of Bologna, and bronze knives of the prehistoric Greek type find their way into the later Terremare. At Orvieto and elsewhere have even been discovered Mycenæan lentoid gems. In Sicily the remarkable excavations of Prof. Orsi have brought to light a whole series of Mycenæan relics in the beehive rock tombs of the southeastern coast, associated with the later class of Sikel fabrics.

Sardinia, whose name has with great probability been connected with the Shardanas, who with the Libyan and Ægean races appear as the early invaders of Egypt, has already produced a Mycenæan gold ornament. An unregarded fact points further to the probability that it formed an important outpost of Mycenæan culture. In 1853 General Lamarmora first printed a MS. account of Sardinian antiquities, written in the later years of the fifteenth century by a certain Gilj, and accompanied by drawings made in 1497 by Johan Virde, of Sassari. Among these latter (which include, it must be said, some gross falsifications) is a capital and part of a shaft of a Mycenæan column in a style approaching that of the facade of the "Treasury of Atieus." It seems to have been found at a place near the Sardinian Olbia, and Virde has attached to it the almost prophetic description "columna Pelasgica." That it is not a fabrication due to some traveler from Greece is shown by a curious detail. Between the chevrons that adorn it are seen rows of eight-rayed stars, a detail unknown to the Mycenæan architectural decoration till it occurred on the painted base of the hearth in the megaron of the palace at Mycenæ excavated by the Greek Archæological Society in 1886. In this neglected record, then, we have an indication of the former existence in Sardinia of Mycenæan monuments, perhaps of palaces and royal tombs comparable to those of Mycenæ itself.

More isolated Mycenæan relics have been found still further afield, in Spain, and even the Auvergne, where Dr. Montelius has recognized an evidence of an old trade connection between the Rhone valley and the Eastern Mediterranean, in the occurrence of two bronze double axes of Ægean form. It is impossible to do more than indicate the influence exercised by the Mycenæan arts on those of the early Iron Age. Here it may be enough to cite the late Mycenæan parallels afforded by the Ægina Treasure to the open work groups of bird-holding figures and the pendent ornaments of a whole series of characteristic ornaments of the Italo-Hallstatt culture.

In this connection, what may be called a sub-Mycenæan survival in the northwestern corner of the Balkan peninsula has a special interest for the Celtic West. Among the relics obtained by the fruitful excavations conducted by the Austrian archæologists in Bosnia and Herzegovina, and notably in the great prehistoric cemetery of Glasinatz, a whole series of Early Iron Age types betray distinct Mycenæan affinities. The spiral motive and its degeneration—the concentric circles grouped together with or without tangential lines of connection—appears on bronze torques, on fibulæ of Mycenæan descent, and the typical finger rings with the besil at right angles to the ring. On the plates of other "spectacle fibulæ" are seen triquetral scrolls singularly recalling the gold plates of the acropolis graves of Mycenæ. These, as well as other parallel survivals of the spiral system in the Late Bronze Age of the neighboring Hungarian region, I have elsewhere * ventured to claim as the true source from which the Alpine Celts, together with many Italo-Illyric elements from the old Venetian province at the head of the Adriatic, drew the most salient features of their later style, known on the Continent as that of La Tène. These Mycenæan survivals and Illyrian forms engrafted on the "Hallstatt" stock were ultimately spread by the conquering Belgic tribes to our own islands, to remain the root element of the late Celtic style in Britain—where the older spiral system had long since died a natural death—and in Ireland to live on to supply the earliest decorative motives of its Christian art.

From a Twelfth Dynasty scarab to the book of Durrow or the font of Deerhurst is a far cry. But, as it was said of old, "Many things may happen in a long time." We have not to deal with direct transmission per saltum, but with gradual propagation through intervening media. This brief survey of "the Eastern Question in Anthropology" will not have been made in vain if it helps to call attention to the mighty part played by the early Ægean culture as the mediator between primitive Europe and the older civilizations of Egypt and Babylonia. Adequate recognition of the Eastern background of the European origins is not the "Oriental Mirage." The independent European element is not affected by its power of assimilation. In the great days of Mycenæ we see it already as the equal, in many ways the superior of its teachers, victoriously reacting on the older countries from which it had acquired so much. I may perhaps be pardoned if in these remarks, availing myself on personal investigations, I have laid some stress on the part which Crete has played in this first emancipation of the European genius. There, far earlier than elsewhere, we can trace the vestiges of primeval intercourse with the valley of the Nile. There more clearly than in any other area we can watch the continuous development of the germs which gave birth to the higher Ægean culture. There before the days of Phœnician contact a system of writing had already been worked out which the Semite only carried one step further. To Crete the earliest Greek tradition looks back as the home of divinely inspired legislation and the first center of maritime dominion.

Inhabited since the days of the first Greek settlements by the same race, speaking the same language, and moved by the same independent impulses, Crete stands forth again to-day as the champion of the European spirit against the yoke of Asia.

* Rhind Lectures, 1895. "On the Origins of Celtic Art," summaries of which appeared in the Scotsman.

THE NEW PSYCHOLOGY.

THE INTERNATIONAL PSYCHOLOGICAL CONGRESS OF 1896.

By HERBERT ERNEST CUSHMAN.

THE first International Pyschological Congress, which was held in Paris in 1889—M. Ribot presiding—was really the result of the efforts of M. Richet and the different societies that had for a long time been formed to discuss hypnotic phenomena and telepathic hallucination. It is important to note that this first Congress took the name of the Congress for Physiological Psychology. The second Congress met in London in 1892, under the name of Congress for Experimental Psychology. The president, Professor Sidgwick, explained the term "experimental" to mean a science founded on observation and experiment. The third Psychological Congress has just held its meetings in Munich, under the simpler name of the Psychological Congress. Of the four hundred and fifty members there were many famous men present—the trim Vaihinger, leader in the Kantian renaissance; the tall and gracious Brentano, at present the only leader of a school in the philosophical world; Ebbinghaus, famous for untiring experiments on the memory; the Frenchmen Janet, Binet, and Flournoy; the veteran Sidgwick; the Jew Münsterberg. Almost every member present had local fame. Conspicuous in their absence were the greatest of all living psychologists, Professor Wundt, of Leipzig, and the most charming of living personalities, Professor James, of Harvard. The American and English delegation was large. In point of numbers, moreover, the Congress was a great success, and the hospitality of the Munich people was unbounded. This Congress represented the development of what is called the "new" psychology from the physiological psychology of the first Congress and the experimental psychology of the second. At first, calling itself physio-psychological in opposition to the old Hegelian idealism, it claimed to be the beginning of a science; then, with enlarged boundaries, it dropped its first name and called itself experimental. Now the territory has been further enlarged, and, experiment and observation having been acknowledged as necessary, it has taken the simple name of psychology. In its first period it embraced only studies in telepathy and other rare mental phenomena; now it includes studies in ethnology, philology, law, sociology, history, epistomology, æsthetics, pedagogics, anatomy, zoology, physiology, psychiatry, and pathology. The subjects discussed by the present Congress classified themselves naturally under five heads:

1. Anatomy and physiology of the brain and the psychology of the senses—thirty-four lectures.
2. Psychology of the normal individual—thirty-four lectures.
3. Pathological and criminal psychology—thirty-six lectures.
4. Psychology of sleep, dreams, and hypnotic states—thirty-six lectures.
5. Comparative psychology and psychology applied in teaching—twenty-eight lectures.

In these two things, then, is the "new" psychology new, (1) in its new standpoint and (2) in the results it has obtained from its new standpoint. Let us consider these a little further.

1. The New Standpoint of Psychology.—The most superficial thinker has heard of the everlasting contention between spiritualism and materialism. Which side does the new psychology take; is it spiritualistic or materialistic? It is neither. It says: "Go to; you are both beyond my ken. I will have nothing with either of you. You are both metaphysicians, while I will be a scientist. You may be both right, but it matters not to me." So the new psychology studies the data of consciousness as an astronomer studies the data of the heavens. The old materialist and spiritualist had always presupposed something behind these data of consciousness—the materialist matter, the spiritualist spirit. Either may be right, but they belong to a world which the new psychology does not enter. The new psychology discusses the facts of consciousness and does not attempt to go behind them. Here, for example, are any facts of consciousness that you please—i. e., feelings, sensations, impulses, thoughts, etc. Such facts are given; but they have two sides—an inner or mental side, an outer or a body side. These sides are called body and mind, for want of a better name. What they are psychology does not discuss, but it discusses the relations between them. The psychical must always be discussed and stated in physiological terms. This then is the standpoint of the new psychology; a scientific discussion of the relations between body and mind—i. e., between the inner and the outer world.*

An extreme exemplification of the new psychology is the notable James-Lange theory that we do not laugh because we are glad or cry because we are sorry, but we are glad because we laugh and we are sorry because we cry. The bodily state is the cause of the psychological state, and not vice versa, and must be stated and investigated in physical terms. Am I in love? What are the physical accompaniments or causes of my mental state? What mathematically and physically stated are conditions of the emotion love? What are the physiological accompaniments—i. e., how does my heart beat, my temperature rise? Does the blood fill my cheeks? Am I angry? What, stated in exact statistics, are the causes of anger? What are the physiological conditions—do I stamp, clinch my fist, flesh my teeth? Am I remembering? What time is required to remember different objects and under differing conditions, such as repetition, diverting objects, etc.? Or is it will power to be tested, or attention, or discrimination, or perception? All mental states must be stated and tested in physical terms. The psychological laboratories of the different universities are used to measure and test in all sorts of ingenious ways the mental states through the bodily states. The most notable laboratory in the world is that of Professor Wundt, at Leipzig; the most complete in its appointments is that at Harvard. Inasmuch as the investigations extend over so large a territory as I have before stated, there can be scarcely any subject that could not be legitimately studied from the "new" psychological standpoint in a psychological laboratory.

2. The Results of the New Psychology.—It would be impossible as well as wearisome in so short a paper to state the results of the new psychology, even if any one man knows all the results. Such a statement would be a series of statistics. The content of consciousness has been divided into its elements by the psychologists, and then these elements studied in their relations. The elements are the several sensations, viz., hearing, sight, smell, etc. In studying the elements of consciousness, the relations above described between the inner and the outer world have been statistically stated with painstaking care. For example, the sounds that the physicist classifies into tones and noises are studied in their psychological relations. What physical conditions give me the comfort of a tone or melody? What give me only noises? Why should certain vibrations of the air be pleasing and others (noises) displeasing? These and very many other questions have been raised and answered in regard to the sense of hearing. With reference to the sense of sight, what physical conditions give us the sense of color, what of non-color? What is color saturation? What psychological state is it that gives rise to deceptions in forms and colors? Do certain colors affect certain sounds?

The same method has been pursued in reference to the senses—smell, taste, and touch. The results obtained have not been, in the majority of cases, novel results; they have usually been the corroboration of what we have already known á priori. A real discovery, however, was made when it was proved that not only historically have all the senses been derived from the sense of touch, but that within the sense of touch are latent and partly developed senses; so that the old-fashioned notion of the five senses vanishes. There are, besides the five senses, the pressure sense, the cold and hot sense, and the pain and pleasure sense. Investigations are going on to ascertain, if possible, if there be special nerves for pleasure and pain. It is easily proved that there are special nerves for cold and heat; for, if a cold iron nail is passed over the skin of the arm, only in spots will it be felt cold. Whether there be special nerves to carry pleasure and pain is quite uncertain. At any rate, the á priori notion of Leibnitz that pleasure is positive and pain negative, and that of Schopenhauer that pain is positive and pleasure negative, could never have been stated by those intelligent minds had they lived among modern psychologists. Pain and pleasure are both positive.†

The psychological elements, i. e., the sensations, are thus studied separately. In actual life, however, no one sensation comes alone. It always occurs in combination with others. Sounds, sights, smells, tastes, and touches occur in conjunction. The world in which we live is very complicated, because it is constructed in various ways out of these differing elements. For example, I am now sitting on the Schlossberg, at Freiburg, with many colors before my eyes—greens, browns, reds, etc., in many forms, regular and irregular. These colors and forms are what my eyes really see. But I seem to see what I call the Black Forest and the Höllenthal and the city on the Dreisam. The noise I now hear is only certain air vibrations, but I call it the bark of a dog, and vibration of the air near me a baby's prattle. That is to say, my psycho-physical organism reacts upon my sensations in such a way as to construct a world that I call the Black Forest, the Höllenthal, and the city of Freiburg. One can easily see how profitable the field of our actual life is for psychological investigation. How is it that the ideas of space and time arise? Why and how are certain colors and sounds associated and not others? What is the object I perceive? How do I perceive it? How do I remember? How make the present world fit the past?

In regard to the question of free will, the psychologist would say, "I know of no supernatural motiveless part of the human personality. Man is free to act as he is constituted to act. Nevertheless, the will is not determined by a single sensation, feeling, or desire. The freedom of the will is this: the psycho-

* This is called by most psychologists the parallelism between the physiological and the psychical. Only of late has the theory been attacked as parallelistic, and the attempt is made to bring the psychical and physical under the law of causality. I append a table here to show the different ways in which the relations between body and mind have been treated.

Psychology.
- Old School Metaphysical.
  - Materialistic.
  - Spiritualistic.
- New School Scientific.
  - a. Descriptive.
  - b. Explicative
    - Intellectualistic.
      - Logical.
      - Associationistic.
    - Voluntaristic.

† The sixth sense is very early developed in the animal kingdom. The Flegelmaus (Vespergo noctula, Vespertilis proterus), a species of bat, has a very highly developed nerve covering its wings. For experiment many of these bats were blinded, and yet could fly about without injury in a dark cavern, guided by this sixth sense.

physical personality as a whole reacting on the outer world."

As to self-consciousness and the unity of the self, the psychologist answers that the feeling of self-consciousness is the general feeling that arises when the psycho-physical personality reacts upon the outer world.

I am aware of the weaknesses of the "new" psychology. It is easily vulnerable at many points. There is no time here for a fair criticism, however, except to say that the last Psychological Congress showed that incorrigible tendency of the German minds to out-Hegel Hegel in their daring theories. In spite of the boasts of the present generation of Germans that the new psychology is scientific and not metaphysical, the words of their own Jean Paul point to one of the dangers to the new young science in the hands of a German—"The kingdom of the English is the sea; that of the French, the land; while the German owns the kingdom of the air." The new psychology claims only to be in its beginnings. Its future will be safe and its effect salutary if it be not overwhelmed by highly inventive theorizing.—The Outlook.

HISTORICAL AND TECHNICAL SKETCH OF THE ORIGIN OF THE BESSEMER PROCESS.*

By SIR HENRY BESSEMER, London, England (Honorary Member of the American Society of Mechanical Engineers).

EVER mindful of the great honor spontaneously conferred on me by the president and council of the American Society of Mechanical Engineers in electing me an honorary member of that learned body, I have deemed it both a privilege and a duty on my part to lay before them a brief account of the early origin of the Bessemer process of steel manufacture, as developed at my bronze powder manufactory in London.

It is generally well known that this invention had its origin in certain experiments commenced in January, 1855, for the purpose of improving the quality of cast iron employed for founding heavy ordnance, by rendering the iron more tough, increasing its tensile strength and making it less subject to injury by abrasion. I was aware that Fairbairn and others had sought to improve cast iron by the fusion of some malleable scrap iron along with the pig iron in the cupola furnace: this fusion of scrap iron, intermixed with the mass of coke, was found to convert the malleable iron into white cast iron, which was at the same time much contaminated with sulphur, and thus, to a great extent, this method had failed in its object. In my experiments I avoided the difficulties inseparable from Fairbairn's plan, by employing a reverberatory furnace in which the pig iron was fused, forming a bath; into this bath I put broken up bars of blister steel, made from Swedish or other charcoal iron, its fusion taking place without being further carburized by contact with the solid fuel, or contaminated by the absorption of sulphur. The high temperature necessary for the fusion of a large proportion of steel in the bath was attained by constructing the firegrate much wider than the bath, by contracting the width of the furnace considerably at the bridge, and also by continuing to taper the furnace slightly all the way from the fire bridge to the downcast flue, which was connected with a tall chimney shaft. My English patent for this arrangement bears date January 10, 1855. Many alterations and modifications of this furnace were made from time to time; it was found that the large volume of flame sweeping over the open hearth of the furnace was mixed with a considerable quantity of combustible gas, to consume which a hollow fire bridge was employed, having numerous perforations made in the fireclay lumps of which it was composed, and so arranged as to allow jets of hot atmospheric air to mingle with these combustible gases, which had the effect of producing an intense heat close down on the surface of the bath; it was also found that the admission of hot air all along the back of the fire bridge produced a decarbonizing action on the bath, and hence the degree of carburation of the metal might be altered by regulating the admission of air. The flow of air through the hollow fire bridge served also to moderate its temperature and render it more durable.

Some of the samples of metal which I produced by this process were, when annealed, of an extremely fine grain and of great strength. At this stage of my experiments I determined on casting a small model gun, which in the lathe gave shavings slightly curled, and closely resembling the turnings from a steel ingot. The metal when polished also looked white and close grained like steel. I was so well pleased with this casting that I took it over to Paris, obtained an audience with, and showed it to, the emperor, who had, in fact, encouraged me to make an attempt to improve iron employed in founding heavy ordnance. His majesty, who had desired me to report progress, accepted this experimental gun, remarking that some day it might have an historical interest, and it was in recognition of this circumstance that his majesty, later on, intimated to me, through Col. Belleville, his desire to confer on me the grand cross of the Legion of Honor, provided I could obtain permission to wear it, a privilege which our ambassadors twice refused. His majesty also gave me permission to erect my furnace at the government cannon foundry at Ruelle, near Angouleme, to which place I went, with proper introductions, for the purpose of arranging all the necessary details. I also sent over from England several thousand special firebricks, etc., for the erection of the furnace.

But on resuming my further researches, after returning to London, an incident occurred which suddenly put a stop to the intended works at the Ruelle Gun Foundry, and, in fact, altered all my future plans and investigations.

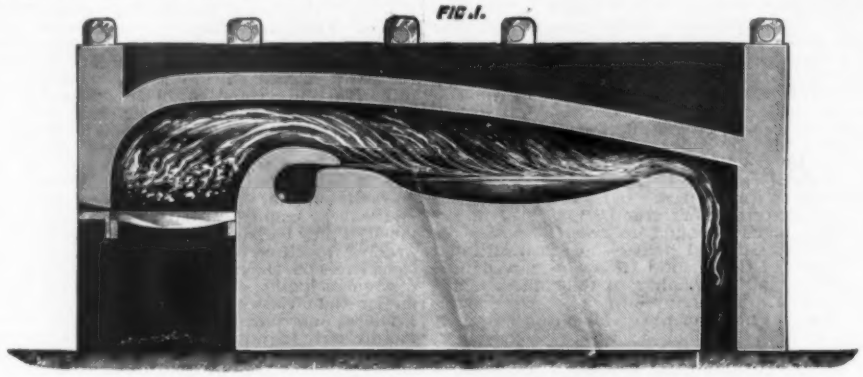
The furnace as it was then arranged is shown in vertical section by Fig. 1, and in horizontal section on a line passing through openings in the perforated hollow fire bridge by Fig. 2, where the narrowing of the body of the furnace is clearly shown, and the manner in which the jets of air were directed so as to produce an intense ignition of the combustible gases mingled with, and passing over, with the large volume of flame, from the overcharged firegrate.

The small scale on which this experimental furnace was built (viz., a capacity of three hundredweight only) was much against my obtaining the high temperature necessary to melt a large proportion of steel in the pig iron bath. I was of course fully aware that a furnace of sufficient capacity to cast a five or a ten ton gun would produce a much higher temperature than it was possible to attain in my small furnace, and also that a forced draught, obtained by closing in the ash-pit and forcing air into it, would also still further increase the temperature. That this forced draught was in my mind at the time, is shown by the fact that I took out a patent for the manufacture of cast steel dated October 17, 1855; that is, about two months after the casting of the model gun; in this patent I fully described the forcing of air by a fan into the closed ash-pits of furnaces employed in the manufacture of cast steel; and it has often since occurred to me that, with the additional resources still untried, I did not act wisely in so suddenly abandoning these open-hearth experiments, in favor of an entirely different system, suggested to my mind by the incident before referred to. But with my impulsive nature and my intense desire to follow up every new problem which presented itself, I at once threw myself unreservedly into this new study, which seemed to open a way to the rapid production of bars, rails, and plates, of malleable metal direct from the blast furnace.

Before dismissing this subject it may be interesting even at this distant period to speculate on what would have been the natural outcome of the open-hearth furnace experiments, had I not been so suddenly diverted from their further pursuit.

Such a furnace, with a forced draught and a capacity of ten tons, would undoubtedly have melted malleable iron or steel in a bath of pig iron and have decarburized it to the desired extent, for I had, in fact, in this small furnace already fused steel in a bath of pig iron on the open hearth of a reverberatory furnace, and as far back as January, 1855, I had claimed in my patent "the fusion of steel in a bath of melted pig or cast iron in a reverberatory furnace, as herein described."

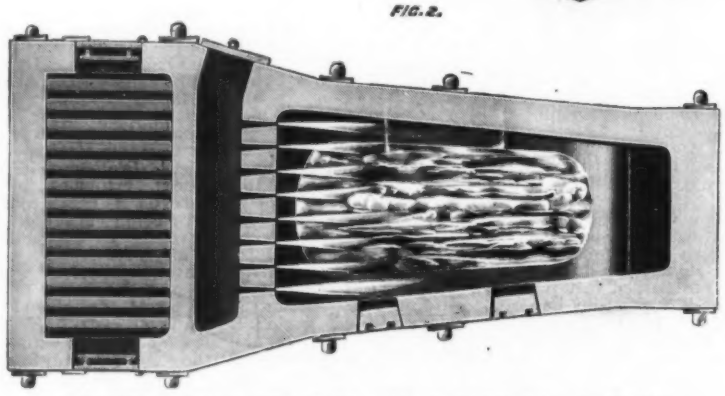
FIG. 1.



REVERBERATORY FURNACE, 1855—VERTICAL SECTION.

FIG. 3.

FIG. 2.



REVERBERATORY FURNACE, 1855—HORIZONTAL SECTION.

This was about ten years prior to the first patent taken out by M. Emile Martin, and now generally known as the Siemens-Martin process. This patent was obtained in England in the name of Emile Martin only, and is dated August 18, 1865, or more than ten years after my patent of January 10, 1855. M. Emile Martin, in his patent, says: "The manufacture is effected upon the principle of fusion of iron or natural steel in a bath of cast iron, maintained at a white heat, in a reverberatory furnace such as a Siemens gas furnace."

I desire to say that I make no claim whatever to the prior invention of the Martin-Siemens process, nor do I

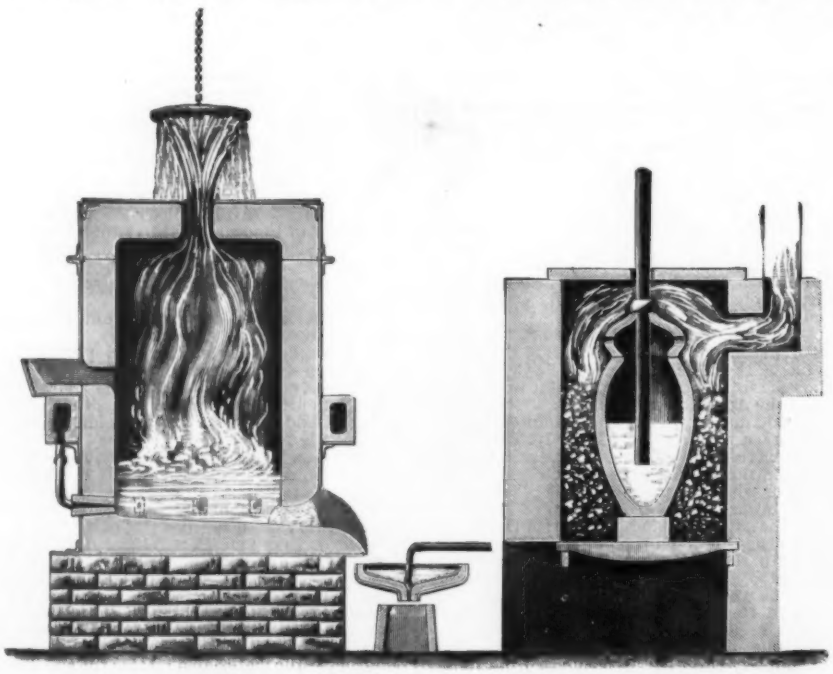


FIG. 5.—FIRST SEPARATE AIR-BLAST CONVERTER.

FIG. 4.—AIR FURNACE AND CRUCIBLE WITH INTERNAL BLOWPIPE.

* Presented at the New York meeting (December, 1896) of the American Society of Mechanical Engineers. From advance proofs furnished by the society.

for one moment assume that my patent of 1855 furnished any information which either of these gentlemen availed themselves of; but I think I am justified in saying that the fusion of steel in a bath of pig iron on the open hearth of a reverberatory furnace, which I had patented and successfully effected, was, to use a favorite expression of Mr. Gladstone, "approaching within measurable distance" of that now well-known and successful process.

On my return from the Ruelle gun foundry, I resumed my experiments with the open hearth furnace, when the remarkable incident I have twice referred to occurred in this way: Some pieces of pig iron in one side of the bath attracted my attention by remaining unmelted despite the great heat of the furnace, and I turned on a little more air through the fire bridge with the intention of increasing the combustion; on again opening the furnace door after an interval of half an hour, these two pieces of pig still remained unfused. I then took an iron bar with the intention of pushing them into the bath, when I discovered that they were merely thin shells of decarburized iron, as represented at Fig. 3, thus showing that atmospheric air alone was capable of wholly decarburizing gray pig iron and converting it into malleable iron without puddling or any other manipulation. It was this which gave a new direction to my thoughts, and, after due consideration, I became convinced that if air could be brought in contact with a sufficiently extensive surface of molten crude iron, the latter would rapidly be converted into malleable iron.

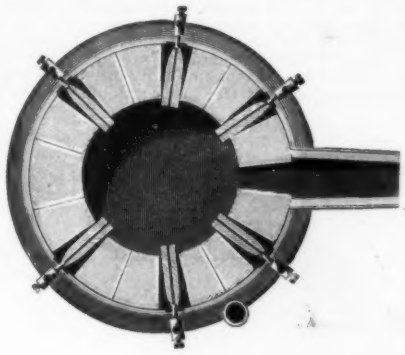


FIG. 8.—CONVERTER WITH UPPER CHAMBER—HORIZONTAL SECTION.

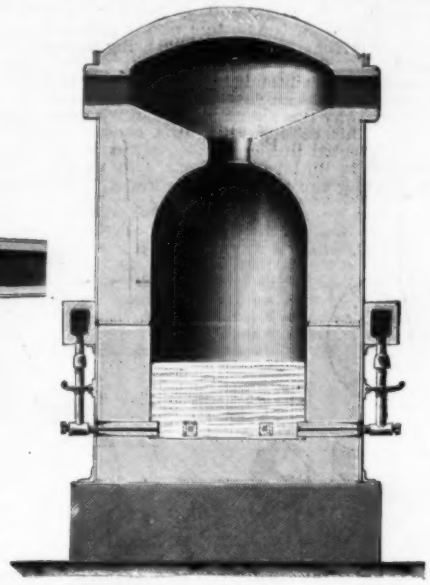


FIG. 7.—CONVERTER WITH UPPER CHAMBER—VERTICAL SECTION.

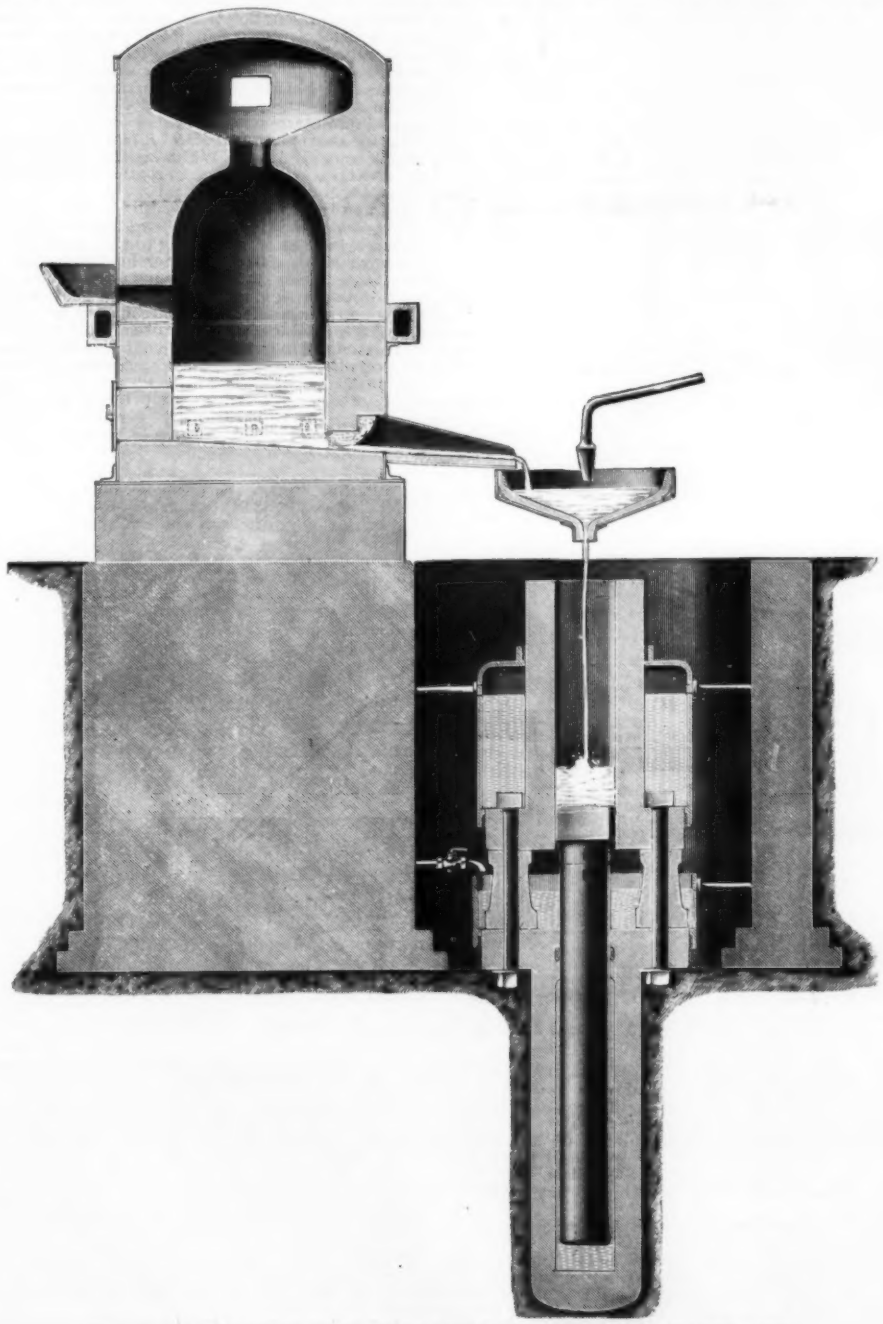


FIG. 9.—CONVERTER AND HYDRAULIC CASTING APPARATUS, 1856.

This, like all new problems, had a special interest for me, and I became impatient to test it by more than a laboratory experiment; without loss of time I had some fire clay crucibles made with perforated covers and also some fire clay blowpipes, which I joined to a three feet length of one inch gas pipe, the opposite end of which was attached by a piece of rubber tubing to a fixed blast pipe. This elastic connection permitted the easy introduction and withdrawal of the blowpipe into and out of the crucible, as shown at Fig. 4, which represents a vertical section of an air furnace, containing a crucible, which in this case represented the "converter." About ten pounds of molten gray pig iron about half filled the crucible, and thirty minutes' blowing was found to convert ten pounds of this gray pig iron into soft malleable iron. Here at least one great fact was elicited, viz., the absolute decarburization of molten crude iron without any manipulation, but not without fuel; for had not a very high temperature been kept up in the air furnace all the time this quiet blowing for thirty minutes was going on, it would have resulted in the solidification of the metal in the crucible long before complete decarburation had been effected. Hence arose the all-important question: Can sufficient internal heat be produced by the introduction of atmospheric air to retain the fluidity of the metal until it is wholly decarburized in a vessel not externally heated?

This I determined to try without delay. I fitted up a larger blast cylinder in connection with a twenty horse power engine which I had daily at work, and I also erected an ordinary foundry cupola capable of melting half a ton of pig iron. Then came the question of the best form and size for the experimental "converter." I had very few data to guide me in this, as the crucible converter was hidden from view in the furnace during the blow. I, however, found that slag was produced during the blow and escaped through the holes in the lid; this fact guided me to the construction of a very simple form of cylindrical converter, about four feet in height in the interior, which was sufficiently tall and capacious, as I believed, to prevent anything but a few sparks and heated gases from escaping through a central hole made in the flat top of the vessel for that purpose, as shown in vertical section at Fig. 5. The converter had six horizontal tuyeres arranged around the lower part of it; these were connected by six adjustable branch pipes, deriving their supply of air from an annular rectangular chamber extending around the converter, as shown.

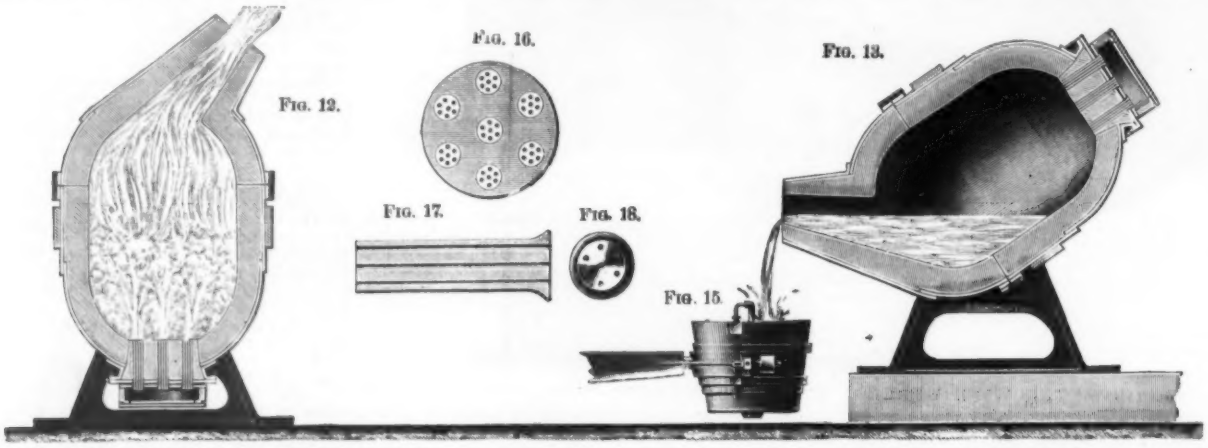
All being thus arranged, and a blast of ten or fifteen pounds pressure turned on, about seven hundredweight of molten pig iron was run into the hopper provided on one side of the converter for that purpose. All went on quietly for about ten minutes. Sparks such as are commonly seen when tapping a cupola, accompanied by hot gases, ascended through the opening in the top of the converter, just as I supposed would be the case, but soon after a rapid change took place. In fact, the silicon had been quietly consumed, and the oxygen next uniting with the carbon, sent up an ever-increasing stream of sparks and a voluminous white flame; then followed a succession of mild explosions, throwing molten slags and splashes of metal high up into the air, the apparatus becoming a miniature volcano in a state of active eruption. No one could approach the converter to turn off the blast, and some low flat since covered roofs close at hand were in danger of being set on fire by the shower of red hot matter falling on them. All this was a veritable revelation to me, as I had in no way anticipated such violent results. However, in ten minutes more the eruption had ceased, the flame died down, the process was complete, and on tapping the converter into a shallow pan or ladle, and forming it into an ingot, it was found to be wholly decarburized malleable iron.

Such were the conditions under which the first charge of pig iron was converted into malleable iron in a vessel neither internally nor externally heated by fire.

I, however, desired to convert a second charge of pig iron, which had been put into the cupola, and in order to prevent this dangerous projection upward of sparks and molten slags, a temporary expedient was resorted to, which, however, failed in its object. I procured one of those circular checkered cast iron plates so much used in the London pavements to allow coals to be put into the cellars below the pavement. This plate, which was about a foot in diameter, was suspended by a chain at a distance of eighteen inches above the central opening, in the top of the converter, as shown in Fig. 5.

This as a mere temporary device was deemed sufficient to allow the conversion of another seven hundredweight charge to be effected without any danger of setting fire to the premises. The converting operation went on quietly as before, but when the eruption commenced I saw the suspended plate get rapidly red hot, and in a few minutes more it melted and fell away, leaving the chain dangling over the opening, and allowing the slags and splashes of metal to shoot upward as before. Thus it happened that the first converter which I had constructed was at once condemned as commercially impracticable, owing to this vertical eruption of cinder, and for this reason only. All attempts to lessen the violence of the process by a reduction of the number of tuyeres, or by lessening the diameter of the tuyere pipe orifices, or by diminishing the pressure of the blast, only resulted in a reduction of the necessary temperature, and in preventing the conversion of the molten pig iron into malleable iron. In one case the trial of a diminished area of tuyere opening resulted in nearly the whole charge of metal, after more than an hour's blowing, being converted into a solid mass of brittle white iron similar to ordinary refiner's plate metal. Indeed, I may say that the results of all my early investigations proved to me, beyond the possibility of doubt, a fact which has since been confirmed in every Bessemer steel works throughout Europe and America, viz., that rapidity of action ending in a violent eruption are absolutely necessary conditions of success; and when we take into consideration the fact

that the converted metal must be made to acquire an enormously high temperature, so that it may not be chilled in tapping, or pouring it out of the incandescent converter into a cold open ladle; that it be not chilled by the addition of a large quantity of much cooler metal employed to deoxidize it; that it does not chill and form a skull in the casting ladle during the comparatively long time required to form it into ingots: it is obvious that to carry out the Bessemer process successfully a temperature must be obtained very considerably above the mere melting temperature of malleable iron. In order to obtain this temperature it is necessary to drive powerful streams of air into the metal, so as to divide it into innumerable fiery globules diffused throughout the whole body of metal under operation, which for the time being may be likened to a fluid sponge, with the active combustion of carbon with



DETAILS OF MODERN BESSEMER CONVERTER, SHOWING POSITION DURING THE BLOW AND DURING DISCHARGE.

oxygen going on in every one of its myriads of ever-changing cavities.

It has been found that the union of carbon and oxygen takes place so rapidly at this high temperature as to produce a series of mild explosions which are scarcely noticed in the large converters in common use which have a space for the violent expansions, of some eight or ten feet in height above the normal level of the metal; in this space the violent action expends itself unseen, and is only partially recognized by a small additional quantity of slags leaping out of the mouth of the converter.

I had no sooner condemned my first cylindrical converter than I commenced to remedy its defects. The most obvious and ready way of doing this would have been simply to make an opening near the top, on one side of it, and thus allow the escape of the ejected matter to take place horizontally, and direct the discharge against a wall, or allow it to fall into a pit, etc., but I desired to prevent the discharge of metal splashes as far as possible, so that I determined on constructing the new converter with an upper chamber having an arched roof and a conical sloping floor. This converter is represented at Fig. 7 in vertical section, and at Fig. 8 in horizontal cross section, taken through the tuyeres. When a converter is so constructed the fluid matters which would otherwise pass vertically upward into the air are thrown against the arched roof, and any fluid metal which may be thrown up falls upon the sloping floor of the upper chamber, and again returns to the lower one, while the flame and a portion of the slags find their way out of the two square lateral openings provided for that purpose. This upper chamber serves also as a receptacle for heating up any metal intended to recarburize or alloy with the steel in course of being converted. The section, Fig. 8, shows six well burned fireclay or plumbago tuyere pipes, fitted to openings left in the lining for that purpose. Their outer ends are made conical to facilitate the ramming in of loam around them, and which effectually holds them in position, and at the same time admits of their easy removal when worn out; a jointed piece of iron tube, with a catch to hold it in place, communicates the blast to each tuyere.

Another view of this converter, taken at right angles to Fig. 7, is represented in Fig. 9, showing in one side the hopper by which the molten iron is run in by a movable spout direct from the cupola. This view also shows the tapping hole open, and the spout which conducts the converted metal into a movable shallow pan or receiver supported by a long handle (not shown). A fire-brick plug, attached to a long handle, is fitted to a fire-brick ring or opening in the bottom of the pan, and prevents any debris from the tapping hole being carried into the mould.

As this apparatus was intended to exhibit the process, it was essential that an easy way should be provided for getting away the ingots and quickly repeating the process. This casting apparatus, constructed precisely as represented in Fig. 9, was erected at my bronze manufactory in London, about two months prior to my reading the "Cheltenham Paper." It is represented in vertical section in Fig. 9. The interior of the mould was 10 in. square and about 3 ft. in length, and was made in two pieces planed quite parallel and then permanently bolted together. The mould had a massive square lower flange resting on four dwarf columns, which stood on the square upper flange of a hydraulic cylinder. Massive bolts passed through these dwarf columns and through the square flanges, and thus united the ingot mould and hydraulic cylinder, in which a ram or plunger was placed, having a movable square head which accurately fitted the mould and formed a closely fitting movable bottom to it. Both the ram and the external surface of the mould were kept cool by a water jacket provided with supply and waste pipes. Matters being thus arranged, the converted metal was allowed to fall in a vertical stream from the receiver on to the head of the ram. The receiver was then removed, and water under pressure was turned on to the hydraulic cylinder as soon as the steel was solidified, when a beautifully square ingot, 10 in. square and weighing about 7 cwt., steadily rose and stood on end ready for removal, the head of the ram rising 1 or 2 in. above the top of the mould. There are, no doubt, many persons still living who witnessed this combined converting and casting apparatus in successful operation at my bronze works in London.

Two 10 in. square ingots made with this apparatus were sent to the Dowlais Iron Works, in Wales, and, without hammering, were rolled into two flat-footed rails, on August 26, 1856—that is, thirteen days after the reading of the "Cheltenham Paper." They were rolled under the personal superintendence of Mr. Edward Williams, past president of the Iron and Steel Institute, where two pieces of these rails are still kept as examples of the early working of my process in London.

I may here call attention to the fact that in my patent, dated October 17, 1855, I described how the state of carburation of the converted metal might be regulated by the addition of molten pig iron after the blow had taken place; and as this patent was dated eleven months prior to Mr. Mushet's patent, claiming to recarburize the converted metal with the German pig iron known as spiegeleisen, Mr. Mushet could not prevent my use of that, or any other pig iron, to recarburize the converted metal after the blow. There was also another absolute bar to Mr. Mushet's claims to the exclusive use of manganese in my process besides its public use in all countries by cast steel manufacturers, for in another patent of mine, dated May 31, 1856—that is, sixteen weeks prior to either of Mr. Mushet's three manganese patents—I gave the right to the public to alloy steel in my process with any metals previously used to alloy cast steel, by showing various ways in which these alloys might be made in my process, either by fluid or solid metals, or by metallic oxides. After this description I entered a disclaimer to their exclusive use, by means of which disclaimer and publication all alloys of steel might be made in my converting process which had hitherto been made by other cast steel manufacturers; so that the three patents of Mr. Mushet, embracing, as they did, every known means of employing manganese, and which were intended to corner me and control my patent, utterly broke down simply by having been anticipated in my two former patents. In consequence of this, Mr. Mushet did not think it worth while even to give me notice that in using spiegeleisen for recarburizing I was infringing his patents, nor did he make any attempt legally or otherwise to prevent me and all my English licensees from the free use of manganese; and I could never understand why American steel manufacturers paid a royalty for the use of these invalid patents.

In this same patent of May 31, 1856, I anticipated the invention of Sir Joseph Whitworth for casting steel under great pressure in order to render the ingots or castings more sound.

I stated that "I have observed that the cellular condition of cast steel, and more especially malleable iron castings, is more or less owing to the spontaneous disengagement of gaseous matter in the interior of the fluid mass. Now, it is well known that substances capable of vaporizing, or of evolving gaseous matters, do so with greater difficulty if surrounded by a dense atmosphere. I therefore make use of this peculiar property of matter in order to increase the soundness of ingots or other articles formed by casting in fluid malleable iron or steel." Then follow details of apparatus both for casting under gaseous pressure and also by the direct action of a hydraulic plunger acting on the fluid steel during its solidification. I have no doubt whatever but that when Sir Joseph Whitworth applied for his patent for casting steel under the pressure of a hydraulic plunger, he was wholly unaware of what I had patented nine years previously, and it is only due to Sir Joseph to say that immediately on his patent agent pointing out this fact to him, he came to me and took a license under my patent, paying me a royalty on all the compressed steel made at his works up to the date at which my patent ceased to exist. That his special mechanical arrangements were an original invention I have never had any doubt whatever, and he had the additional merit of successfully carrying them out.

Before concluding this brief sketch of the more salient points connected with the many forms of apparatus de-

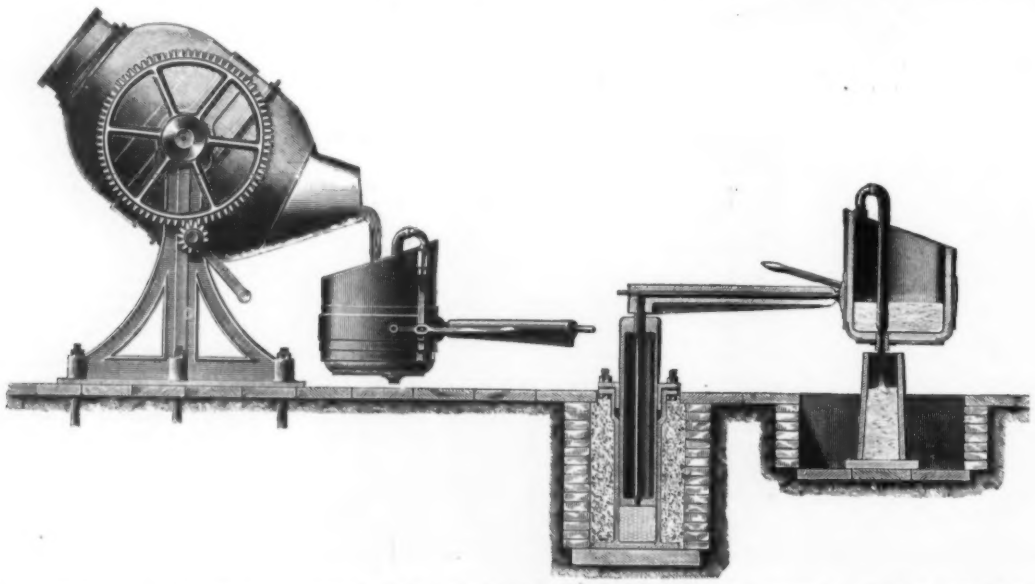


FIG. 19.—THE FIRST MOVABLE CONVERTER ERECTED AT THE BESSEMER STEEL WORKS, SHEFFIELD.

signed by me to facilitate or improve my process, I must revert to the difficulties inseparable from a fixed converter, for in this form of apparatus much heat is dissipated by the necessity of blowing before running in the metal, and, what is still worse, the necessity of continuing the blast after the metal is converted and during the whole time of its discharge. Then there is the uncertainty as to the time employed in tapping, during which time the blowing must be continued, and there is also the difficulty of stopping the process, if anything goes wrong with the blast engine, or if a tuyere gives way.

These difficulties and many others caused me to search diligently for a remedy for these grave defects, which at that time appeared impossible to overcome, until the happy idea occurred to me of moving the converter on axes, so as to be able to keep the tuyeres above the metal until a charge of molten iron was run in, and which permitted the whole charge to be commenced at one and the same time, and admitted also of the cessation of blowing during its discharge. This movement of the converter also permitted a stoppage of the process to take place at any time for the removal of a worn out tuyere if necessary, and afforded great facilities for working the process. The peculiar form of the movable converter was a matter of great importance as there were several necessary requirements to provide for. First, in order to make the heavy lining secure when turned upside down, a more or less arched shape in all directions was necessary, and a long oval form seemed best adapted to the purpose, as it allowed some eight or nine feet in height for the metal to throw itself about in, without leaving the converter. Then the large mouth or outlet pointing to one side was necessary to direct the sparks to be all discharged in a direction away from the casting pit. After much study the precise form arrived at is shown at Figs. 12 and 13, of which Fig. 12 shows the position it occupies during the blow, and Fig. 13 shows the position it assumes during the discharge of the converted metal into a loamed-up casting ladle provided with a discharge valve at the bottom; the ladle can be moved from mould to mould by closing the valve during such movement, and on opening it a vertical stream descends into the mould, perfectly free from any admixture of slags. The advantage of this mode of filling the moulds will be understood when it is borne in mind that the latter are necessarily narrow, upright iron vessels. Now, it is well known that a stream of molten metal, poured from the lip of a ladle, will describe a parabolic curve in its descent, and tends to strike the further side of the mould before reaching the bottom. The surface of the cast iron mould so struck is instantly melted by the incandescent stream of steel, and the ingot and the mould thus become united, causing great inconvenience and destruction to the mould; nor is it easy in pouring the steel from a ladle to prevent some of the fluid slag floating on its surface from flowing over with the steel and spoiling the ingot. All of these difficulties are avoided by the valvular ladle discharging a vertical stream down the center of the mould, the quantity and flow being regulated with great facility by the hand lever on the side of the ladle.

Many other mechanical contrivances were necessary to perfect the process: such, for instance, as a patent blast engine with noiseless self-acting valves; the hydraulic casting crane carrying the casting ladle over every mould in the semicircular casting pit, and capable of rising and falling to correspond to the descent of the mouth of the converter when filling the ladle for casting. Then there are the direct-acting ingot cranes which clear the pit and refill it with another set of moulds rapidly and with little manual labor; then we have the elevated "valve stand," called in America "the pulpit," from which safe position a single workman can overlook the whole converting apparatus, controlling all their movements, governing the blast, working the hydraulic cranes, etc.

The mode of transmitting semirotary motion to the converter was another important question which I had to solve. I was of opinion that ordinary shafting and straps were out of the question in dealing with this fiery monster; five or ten tons of fluid metal had to be lifted in one direction, the load diminishing until the fluid running to the opposite end of the converter tended to drive the lifting gear in the reverse direction, so that if anything went wrong or slipped, the converter might swing itself round and discharge these five or ten tons of incandescent steel on to the floor or among the workpeople. This determined me to adopt the hydraulic apparatus now universally employed for governing the motions of the converter, for with this simple and reliable apparatus, a lad at safe distance can start it in motion or stop it instantly, can alter its speed of motion, and control the pouring out of ten tons of incandescent steel as easily as a lady pours out a cup of tea.

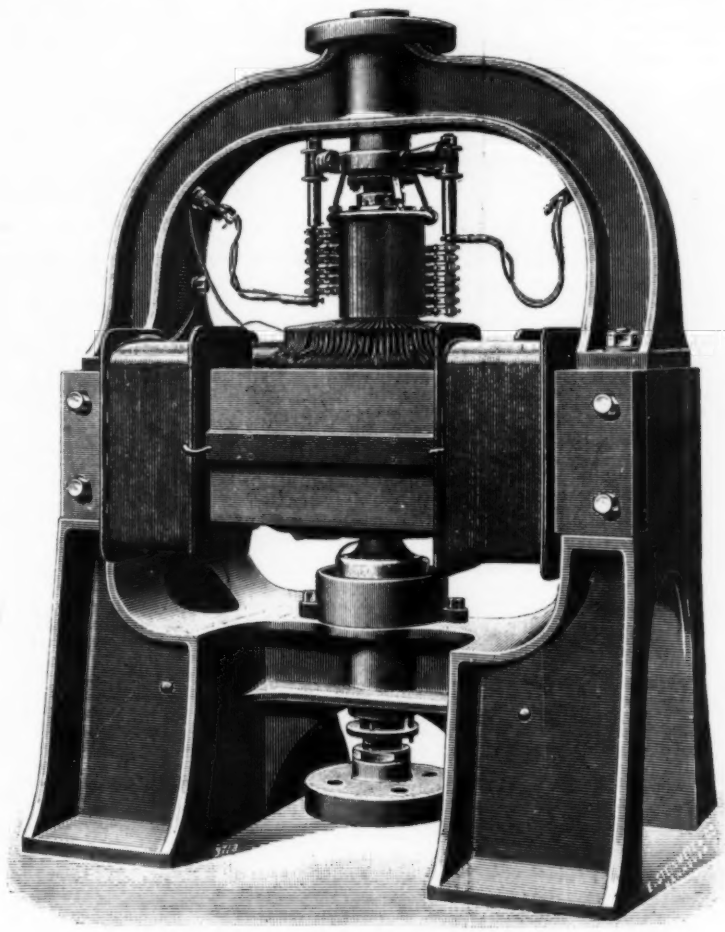
The first movable converter was erected at my steel works in Sheffield, and was moved by hand gearing, because at that early date I had not invented the hydraulic apparatus just described. This early converting apparatus did good work at Sheffield, and was constructed precisely as represented in Fig. 19, which shows also the first modification of the hydraulic casting crane, afterward elaborated and rendered suitable for casting heavy charges of steel.

In conclusion, permit me to say that I have great pleasure in bringing before the many eminent engineers of which this society is composed a brief sketch of the early days of this invention, and although many interesting details are necessarily omitted, I trust that I have said enough to show how the Bessemer process originated, and how, by constant study and practical research, it was developed from a mere abstract theory, nearer and nearer to a degree of practical development at my bronze works in London till I was justified in erecting the Bessemer Steel Works in Sheffield, which still remain in active operation under the style of Henry Bessemer & Company, Limited. These works were established for commercial purposes and also to serve as a pioneer works or school, where the process was for several years exhibited to any iron or steel manufacturers who desired to take a license to manufacture under my patents; during that time all who desired to do so were allowed to bring their own pig iron, and personally, or by their managers, see it converted prior to taking a license.

And now, when I contemplate the great steel trade of Europe and America, with an annual production of 10,000,000 tons of Bessemer steel, I may be pardoned if I express some pride and satisfaction when I find that, notwithstanding the keen competition of rival manufacturers and the ceaseless activity and inventive talents of mechanical engineers, my original invention has not been swept away, but still exists in active operation in every steel making country in the world, intact in all its main features and in almost every detail as it left my hands forty years ago.

MOTOR FOR DRIVING CENTRIFUGAL PUMP.

WE illustrate one of a set of eight electric motors constructed by Messrs. Ernest Scott & Mountain, Limited, of the Close Works, Newcastle-on-Tyne, for driving the centrifugal pumps used for clearing the water from a large floating dock. As will be seen, the armature axis is placed vertically, being fitted with a coupling below to bolt on to another flange on the pump spindle. The field magnets are bolted to a heavy cast iron standard which also supports the bearings of the armature spindle. The commutator is located on the upper portion of the machine, being therefore easily accessible. The motors are designed to run at 350 revolutions per minute, at which they develop 60 effective horse power.—Engineering.



ELECTRIC MOTOR FOR CENTRIFUGAL PUMPS.

THE REMOVAL OF IRON FROM DRINKING WATER.*

AT Aurich, in East Friesland, a tube well 36 mm. in diameter was put down to a depth of 84 meters in alluvial ground for the purpose of supplying the barracks; but the water, although free from organic matter, was unfit for use on account of the large amount of iron in solution, amounting to 19·2 mgrms. per liter, and, when exposed to the air, became brown and turbid from the formation of ferric hydrate when the carbon dioxide which kept the iron in solution had escaped. As no other supply could be got, it was decided to purify it by the method adopted by C. Piefke, the separation of the iron being facilitated by breaking up the mass of water into numerous fine streams so as to obtain the largest possible contact with the atmosphere. The apparatus consists of a rectangular iron scrubber 3 meters high, 2 meters long and 1 meter broad, filled with lumps of coke. The water is distributed by a series of perforated plates uniformly over the top of the coke column and passes downward into a collecting chamber below, and from thence through a sand filter bed 640 mm. thick, with about 11 square meters area, that of the scrubber being 2 square meters. The proportion of iron was diminished from 19·2 to 7·21 mgrms. per liter in the scrubber, and to 1·08 mgrms. after passing the filter. The apparatus was intended to treat 3½ cubic meters per hour, under which condition the rate of delivery per square meter was 1,750 liters in the scrubber and 380 liters in the filter.

The removal of the ocher deposit on the coke is effected from time to time by stopping the communication with the filter and allowing the water from the pump to flow for a short time in a single stream through each of the distributing plates in succession. The strong current thus obtained detaches the deposit. A similar coating accumulates on the top of the filter, rendering it nearly, if not quite, impermeable to water, so that about two meters of the upper part must be renewed at intervals of three or four weeks.—H. Schuster, Zeits. des Ing. und Arch. Ver. zu Hannover, 1894, 297; Proc. Inst. Civil Eng., 1894, 118, 34, 35.

FREEZING POINTS OF ORGANIC COMPOUNDS AND OF ALCOHOL.

THE peculiar regularity with which the boiling points of homologous organic compounds rise with the introduction of certain groups naturally led to the conclusion that a similar regularity ought to prevail with regard to the freezing points. In many cases, however, those compounds remained liquid at the low temperatures which can be produced in an ordinary laboratory. The Pictet Institute, at Berlin, has taken up these researches, of which Dr. Altschul gives a preliminary account in the Zeitschrift für die Gesammte Kälte-Industrie.

In the aromatic series, the methyl group produces a lowering of the freezing point: thus benzene freezes at +7° Centigrade, toluene at —100°, aniline at —8°, methyl aniline was still liquid at —80°. The substitution of hydrogen by chlorine raises the freezing point by a decreasing amount. In homologous acids like acetic acid (freezing point +16·5°), proponionic acid (—24°), normal butyric acid (—19°), the freezing points rise and fall, those with an odd number of carbon atoms having the lower freezing point. This was already established by Bayer.

Of several isomers the most symmetrical is most difficult to crystallize; isobutyric acid would not congeal at —80°. The investigation of the behavior of mixtures induced Dr. Altschul first to inquire into the mixtures of various alcohols with water. The research was conducted in two ways, starting from absolute alcohol and adding water, and vice versa. The first series of experiments gave a hyperbola, the second, when more and more alcohol was admixed to the water, a series of straight lines joined by more or less regular curves. This would indicate that certain concentrations simply represent solutions of alcohol in water, like solutions of salts, while there are also certain hydrates; but the investigations are not concluded yet.—Trades Journal Review.

In the Havemeyer Building, New York City, they have recently put an Ingersoll air compressor in the engine room, and supply air to all the floors of the building. Any of the tenants who want air can have it. The Ingersoll-Sergeant people themselves will probably be the largest users, as they use air to run all their tools for exhibition purposes in their show room. The doors are opened by air, call bells are operated by air, letter presses are operated by air, and the furniture is dusted and carpets cleaned by compressed air. This is a new feature in office buildings, and may become a very popular one. Anybody that knows anything about compressed air knows that when air is compressed it is heated and when it is expanded it is cooled. Perhaps the time may come when a jet of air in the office, in the heat of summer, will be used as the most convenient and effective way of cooling.

The German miners are, in the opinion of the Berlin Reichsanzeiger, among the best paid in the world, their income ranging from $225 to $300 per year, with gifts of land and life insurance added.

ENGINEERING NOTES.

Official reports of the trials of the Sparrowhawk torpedo boat destroyer, built by the Lairds, give an average of 30·2 knots on the measured mile and 30·68 knots for the three hours' continuous steaming trial.

The proportions of passengers killed and injured on the railways of the United Kingdom during 1895 were one in 11,202,059 killed and one in 838,387 injured. In 1894 the proportions were one in 7,789,854 killed and one in 780,319 injured. In 1895 five persons were killed and 399 injured, as against sixteen killed and 347 injured in 1894.

The 30 knot torpedo boat destroyer Fame, built by Messrs. Thornycroft & Company, had, on October 28, a preliminary trial to test her coal consumption, so as to determine the load which she could have carried on the full speed trials. The average speed attained during the three hours' run was 29·579 knots. The Fame returned to Chatham.

Pneumatic tubes for carrying mails are to be laid across the Brooklyn Bridge, connecting the main post offices of New York and Brooklyn. There will be two 8 inch tubes, the terminals and power plant being in the two post offices. The right to lay the tubes has been granted to the New York Mail and Transportation Company, at a rental of $1,000 per year for five years. The work is to be done under the supervision of Mr. C. C. Martin, chief engineer, and is to be completed by March, 1897. The company will receive $14,000 per year from the government.

An underground railway in Paris, about 11,054 feet long, is to be built to transfer the terminal station of the Compagnie d'Orleans from the Place Valhubert, some distance up the Seine, to the Quai d'Orsay, opposite the gardens of the Tuileries and in the heart of Paris. The new line will follow the left bank of the Seine and will be, for the greater part, in a double track masonry tunnel, with the floor just above the level of the water in the river. About 2,027 feet near the present station will be a sunken track, open above. The total estimated cost is about $4,600,000.

It seems that at the Obouchoff Steel Works, St. Petersburg, great inconvenience was felt for a long time in casting large round ingots of five tons and upward; the stream of steel falling from a considerable height into the mould from the thirty ton ladles of the Siemens-Martin furnaces gives rise to a considerable quantity of splashes; these producing cracks on the surface of the ingots. To prevent this splashing, a method has been devised which consists in preparing a thin tube of sheet iron, of two feet inside diameter and suspended from an iron ring, to which there are riveted three bars on the surface of the mould just before casting; the steel is poured from the bottom of the ladle into the middle of the tube. All the splashes are thus thrown on the walls of the iron tube, which gradually melts away during the rise of the surface of the liquid steel in the mould.

It is asserted that repeated experiments have proved, in the transmission of power, that ropes and belts, when well arranged, absorb almost the same amount of power. Some French trials in this line, as reported in Engineering Mechanics, were made, it appears, with a 200 horse power engine, fitted with rope and belt fly wheels, 14¾ feet in diameter. The steam engine had a fly wheel for the belt and one for the ropes; the dynamo was driven direct off the fly wheel, without a countershaft, and was provided with two pulleys, one for the belt and one for the ropes. The dynamo was driven direct off the fly wheel, being mounted on adjusting screws, so that the tension of the belt or ropes could be regulated at will. A cotton belt, a leather belt and a homogeneous leather belt and ropes were of standard quality. Experiments of a comparative nature were made alternately, with the ropes and belts, several tests each day, the results being as above indicated.

Gas tramcars were run last summer between Hirschberg, Warmbrun, and Hermsdorf (8·4 miles); a line is to be run to connect Rudesheim with Biebrich, Wiesbaden, Cassel, and Mayence (27 miles); a line is in view for the suburban service of Hanover; a line at Colmar, probably; experiments are being made at Maestricht, Charlottenburg, Mannheim, St. Petersburg, Copenhagen, and will be made in eight other Continental towns. Paris is also experimenting on the Gas Traction Company's cars, with the following results: Horse power, 12 to 15; revolutions per minute, 100 to 250; volume of gas reservoirs, 44·2 cubic feet; initial pressure of gas, 10 atmospheres; volume stored, 443 cubic feet; water, 16½ gallons; number of passengers per car, 42; weight of car, empty 7 tons, full 10 tons; gas used per car mile, exclusive of gas used for compression, 31·1 cubic feet; maximum speed, 10 miles an hour; longest run without recharging, 14 miles. With gas at 4s. 6d. this comes to 1·306d. per mile run; and with establishment charges at 1½d. a mile, and upkeep of cars at 1½d. this comes to 3·723d. per car mile, as against 5½d., the actual cost of electric car running in Paris. The experiment seems quite satisfactory from the point of view of comfort.—Gas World.

A curious result is recorded of some experiments carried out at the Continental Ironworks, Brooklyn, on the endurance of steel and cast iron columns under load at high temperatures, says the Iron and Coal Trades Review. The columns in question were placed upright in a furnace supplied with gas from a producer of the ordinary type, and were loaded by hydraulic pressure. A test of a built up steel column showed that when at a red heat it failed to carry more than a small load. It appeared that such a column was reduced in strength by nearly seven-eighths when raised to a temperature of 1,200° F. The next experiments were on hollow cast iron columns, having an estimated breaking strength of 902,000 pounds. The column when at red heat failed under a load equal to 84·8 tons. In another experiment, a cast iron column under the same load had a jet of water thrown on it when the pyrometer indicated a temperature of 675°, without showing any signs of injury. This experiment was repeated at temperatures of 775° and 1,075°, and, finally, when the column had reached a light red heat and was beginning to yield. In no case did the water seem to have any injurious effect upon the column, contrary to what would have been expected.

ELECTRICAL NOTES.

Thirty-nine miles an hour was made by a special car on the Akron, Bedford & Cleveland Electric Railroad, between Cuyahoga Falls and Newburg, Ohio, recently.

When printing from the roll, printers are often troubled with electricity in the paper. A small supply of live steam discharging into a tin pan underneath the roll will overcome the difficulty, besides improving the condition of the paper for printing.—The American Bookmaker.

A remarkable electric wire accident took place in Calais, France, on November 6. While a huge boiler was being drawn through the streets by 16 horses the upper portion of it came in contact with overhead electric light wires, breaking them. Some of the wires caught on the boiler and the framework of the truck, and in an instant all the horses were knocked down. Several of them were killed. The men engaged in transporting the boiler received violent shocks, some of them being probably fatally injured.

Mr. G. Folgheraiter, whose communications on the subject of magnetometric methods will be found, says Electricity, in the Atti dei Lincei, proposes to determine the inclination of the earth's magnetic force in bygone ages from the magnetization observed in Tuscan and other vases. The author proved, by imitating the manufacture of such vases in baked clay, that during the process of firing they are slightly magnetized by the earth's field. Assuming that they were placed upright in the furnaces and that the magnetization was permanent, conclusions may be drawn with regard to the field of the earth at the time. The relation between its direction and that of the magnetization is being investigated by means of experimental cones and cylinders placed in various positions.

It is proposed by the electrician of the St. Louis and Suburban Railway to establish and maintain a bicycle corps, the duties of which will be to answer calls and patrol certain sections of the road. A few days ago one of the line workers used a wheel, and the result of the experiment proved satisfactory. Where minor troubles develop, one working electrician is generally enough to remove the fault. Where there is trouble at any point along the line the "hurry-up wagon" and three or four men are dispatched. Often several calls are received at the same time from different localities, and all of them cannot be answered at once. With a bicycle corps this difficulty would, in a measure, be overcome. Defects in overhead work would also be discovered before they developed trouble.

Some interesting experiments have recently been conducted by A. Hagenbach, in the Annalen der Physik und Chemie, on the subject of thermo-elements composed of amalgams and electrolytes. He determined the thermo-electromotive force for elements consisting of the following chain: Cadmium amalgam | solution of a cadmium salt | cadmium amalgam, and of a similar chain for lead. The sulphate, nitrate, chloride, bromide, and iodide of cadmium, and the nitrate and chloride of lead were employed at various concentrations. One electrode was maintained at a temperature of about 6°, and readings taken with the second electrode at temperatures ranging from 6° to 80°. The thermo-electromotive force was found to be approximately proportional to the temperature, except for lead chloride, where it remained almost constant from 30° to 50°, while, contrary to expectation, the E.M.F. decreases with increasing dilution, the decrease varying with the different salts. The original paper may be found in the Annalen der Physik und Chemie, 1896 (2), No. 58, p. 21 to 36, says the English Electrical Review.

The largest contract so far given out for electric pumps in the United Kingdom has just been secured by Messrs. Ernest Scott & Mountain (Limited), of Newcastle-on-Tyne, says the Steamship. The Arniston Coal Company, of Gorebridge, N. B., have decided to employ electricity for the draining of their mine, and the result of tenders has been the selection of the above firm for the execution of the work. The steam plant is to consist of two 300 horse power Corliss horizontal triple expansion engines, running at 84 revolutions, and two 30 ft. by 8 ft. Lancashire boilers. To these are connected two rope-driven continuous current dynamos of 200 kw. capacity, with a voltage of 525; the dynamos are on sliding bed plates for the regulation of the rope strain. All this plant is on the bank, and the electricity is conducted from a switchboard down the shaft by means of four armored cables to four sets of Scott & Mountain's three-throw pumps. One pump delivers 500 gallons a minute against a head of 270 ft. along a road some 1,200 yards long to a sump at the bottom of the shaft; and a second pump of the same size forces the water to bank, a distance of 690 ft. The firm has in hand a quantity of work of a similar type.

In several instances of late we have noted, says the Electrical Review, newspaper reports of fires in the remote suburbs of cities where fire extinguishing apparatus was hurried to the scene by being towed by electric cars, better time being made over heavy or poor roads than was possible by animal power. In the recent burning of some of the summer pavilions at South Beach, Staten Island, it is reported that a fire engine was dragged to the scene in this manner. The superior advantages offered by interurban or suburban electric railroads for the rapid conveyance of fire extinguishing apparatus have appealed to the fire commissioners of Springfield, Mass., and it is now proposed to build and equip a car to be propelled by its own motors, on which a fire engine and other apparatus may be carried to any of the neighboring communities connected with it by the trolley railway systems. Drawings have been made for a platform car to be set as low as possible, both in order to facilitate loading and to clear several low overhead bridges. Suitable guards and clamps will secure the fire engine on the platform, and a hose wagon or chemical engine may be carried on a trail car. It is proposed to keep such a car at one of the fire stations, so located as to enable direct connections with any of the suburban electric routes, and the motor equipment is intended to be sufficiently powerful to allow of towing a ladder truck on its own wheels to points which may be reached over paved highways.

MISCELLANEOUS NOTES.

The following is an ordinance which was in force in 1734 at the iron smelting works in Wasseralfingen, Wurtemberg: "No workingman will be allowed to stay out at night, and should he be found in a saloon at 8:30 P. M., he shall be arrested and put in jail."—Stahl und Eisen.

From a recent consular report we learn that most of the olive oil extracted in several districts in Persia is made into soap on the spot. The proportions of materials used are lime, four parts; alkali, ten; olive oil, twelve; and salt, one. Since the price of oil has risen, suet is added in equal proportions to the olive oil. It is said that the soap made with the addition of suet is, when kept, of an excellent quality, and well adapted for washing clothes and all rough work generally.

The production of Para rubber increased from 8,243,000 pounds in 1865 to 15,144,000 in 1875, 29,310,000 in 1885, and 46,363,000 pounds in 1895; the great advance in the decade between 1885 and 1895 being the direct result of the increased demand produced by the tire-makers. Last year 37,456,000 pounds were delivered to manufacturers in the United States, against 31,062,000 pounds in 1894 and 35,583,000 pounds in 1893. The highest price paid in this country last year for fine Para rubber was 81½ cents, in November.

The number of applications for British patents was 25,065 in 1895. This is a slight decrease from the number in the two preceding years, 25,107 in 1893 and 25,386 in 1894. The decrease is principally in patents taken out by citizens of the United Kingdom, about 1,100 less than in 1894. Citizens of the United States took 2,017 English patents in 1894 and 2,325 in 1895. Germans were second among foreigners, with 1,945 in 1894 and 2,146 in 1895. The number of British patents taken out by residents of France was 799 in 1894 and 894 in 1895. No other nation secured more than 500 patents.

A Manchester photographer, according to the scientific and industrial department of the Atlanta Constitution, relates that he recently took a photograph of a child who was apparently in good health and had a clear skin. The negative showed the face to be thickly covered with an eruption. Three days afterward the child was covered with spots due to prickly heat. The camera had seen and photographed the eruption three days before it was visible to the naked eye. It is said that another case of a similar kind is recorded, where a child showed spots on his portrait which were invisible on his face a fortnight previous to an attack of smallpox.

M. Pellegrin, French consul at Valencia, says that the east and southeast of Spain are, properly speaking, the only parts of the peninsula where the silk cultivation and industry have attained anything approaching a high degree of development. The yield of cocoons in 1895 amounted to 1,200,000 kilogrammes, as compared with 1,100,000 kilogrammes in 1894. The cultivation of silk and its derivatives are contemporaneous with the domination of the Arabs, who introduced it from Asia Minor. Favored by an extremely favorable climate, this description of production soon began to constitute the chief wealth of the provinces of Valencia, Castellon and Teruel. The transformation of the cocoon into silk remained for a long time, in a certain sense, a home industry, as the breeder of the worms himself attended to it. Using for this purpose the most primitive of apparatus, the result was defective. The initiative of modernizing the silk spinning industry in Spain is due to a Frenchman, a native of Forey, M. J. Louis Dupuy de Lome.

Strange as it may appear, flint muskets are not a relic of a bygone age. Last year no fewer than 1,820,000 gun flints were produced at the Lingheath mines, Brandon, Suffolk, England. These flints are chiefly applied to arms which are destined to delight African and other savages, who, having so long been used to flint locks, are reluctant to give them up. The method of manufacture of these gun flints is very interesting. In the operation of "flaking," the worker will take a "quarter" in his left hand, and, placing it on his knee, round which a protecting band of leather has been strapped, gently tap the flint with a hammer, giving it each time a well directed blow. At every tap a flake 6 in. long and 1 in. wide falls into his hand, and if a good one, is deposited in a pail by his side, all bad ones being discarded. The "knappers" work these flakes with hammers with long thin heads, often made of old files, transversely breaking the strips of flint on an iron ridge fixed in their benches. After this they carefully flake them till they get a complete gun flint. A flaker can make 7,000 or 8,000 flakes in a day of twelve hours, and a knapper will finish 3,000 gun flints in the same time. There are four sizes of flints in use: the musket, the carbine, the horse and the single.

The influx of college women is still so recent that statistics of their careers have not ceased to be interesting. Mrs. Sidgwick, the head of Newnham College, England, has lately collected and tabulated information dealing with the occupations of those who have been at the college, the result being reported in the Queen. The total number of students who have left between October, 1871, and June, 1893, was 720; of this number only 667 need concern us, as of the remainder some have died and some are foreigners who have returned to their native land. Of these 667 we find that 374 are engaged in teaching, 230 are living at home (of whom 108 are married), five have gone into the medical profession, two are missionaries, one is a market gardener, one a bookbinder, two or three are engaged in charity organization work, and the remainder are said to be "for the most part engaged in secretarial work." It will be noticed that more than half have taken to teaching, and of these it is cheering to observe only seven set down as "looking for posts." Less than one-sixth have married; the proportion is small, and it would be interesting to know whether it is smaller than that prevailing generally among women of the same class and the same age. We do not hear of any writers, but to our knowledge at least three are principally so engaged, one being known as a writer of short stories and sketches, one as a journalist, and the third as a remarkably successful translator.—New York Times.

SELECTED FORMULÆ.

Chilblain Remedy.—The following formula is recommended as being efficacious in cases of chilblains:

Ichthyol..	} of each.....	1 gramme.
Resorcin..		
Tannin...		
Water.....		5 "

To be rubbed on the affected parts every night. In a few minutes it forms a varnish on the skin, and under its influence it is affirmed that not only the chilblains disappear, but also the swellings of the hands and fingers. The drawback to this preparation is that it blackens the skin during treatment, and for eight or fifteen days afterward. In the case of those people whose occupations prevent them soiling their hands, resorcin may still be employed in the following manner:

Resorcin.		2 grammes.
Mucilage of acacia	} of each.....	5 "
Water.....		
Powdered talc....		1 "

To be rubbed on at night.

A Few Mordants Worth Knowing.—To etch aluminum:

Alcohol.....	4 ounces.
Acetic acid....	6 "
Butter of antimony.....	4 "
Water.....	40 "

For brass, use:

Alcohol.....	4 ounces.
Chromic acid..... ...	4 "
Water.....	40 "

To etch lead:

Alcohol.....	4 ounces.
Tin bichloride..... ..	2½ "
Water.....	40 "

—Anthony's Bulletin.

Copying Pad Material and Hectograph Ink.—Copying material:

Gelatine...	2 lb.*
Glycerine.....	1½ gal. (15 lb. av.)
Water, sufficient quantity.	

To the gelatine add sufficient cold water to cover it, and let stand over night. Then pour off as much of the water as possible, add the glycerine to the softened gelatine, and heat the mixture to about 212° F. Continue the heat for about an hour, or until most of the water has been slowly evaporated. Finally strain through cheesecloth while hot. Care should be taken not to heat the gelatine too long, as it will then lose its power of gelatinizing.

HECTOGRAPH INK.

Methyl violet 3 B.....	1 ounce.
Water	8 "
Glycerine.....	1 "
Alcohol.	2 drachms.

Dissolve the violet in the water by the aid of gentle heat; add the glycerine, and allow to cool; then add the alcohol.

To Gild Brass, Copper or Silver Without a Battery.—The following gilding solution will deposit a smooth and brilliant layer of gold on silver, brass, copper, etc., without the intervention of electricity:

Gold chloride.....	20 parts.
Potassium cyanide	60 "
Potassium bitartrate	5 "
Prepared chalk....	100 "
Water, distilled....	100 "

Dissolve the gold chloride in a portion of the water and the potassium salts in the remainder. Mix the solutions and stir in the prepared chalk. The articles to be gilded should be rendered free from grease, oxidation, etc., and the mixture applied with a woolen rag and rubbed well on.

Cider Preservatives.—Effervescent Cider.—Calcium sulphite (sulphite of lime) is now being largely used by professional cider makers to prevent fermentation in cider. They prefer it to sulphurous acid gas and mustard, because of its greater convenience and economy. About one-eighth to one-quarter of an ounce of the sulphite is required for one gallon of cider. It should first be dissolved in a small quantity of cider, then added to the barrel, and the whole agitated until thoroughly mixed. The barrel should then be bunged and allowed to stand for several days until the full action of the sulphite is exerted. It will preserve the sweetness of cider perfectly, but care should be taken not to add too much, as that would impart a slight sulphurous taste.

Salicylic acid is also used as a preservative and by some is considered superior to calcium sulphite. About one part of acid in two thousand of cider is said to be the proper proportion. The acid should be first dissolved in a very small quantity of alcohol, then added to the cider and thoroughly mixed.

An effervescent cider may be obtained by adding a small quantity of bicarbonate of soda to the cider in bottles, just before driving the corks. Too much soda will spoil the taste of the cider.

The following has been published as a formula for the so-called champagne cider: To 100 gallons of good cider add 3 gallons of strained honey or 24 pounds of granulated sugar. Stir well, and set aside for a week. Clarify the cider with half a gallon of skimmed milk, and add 4 gallons of alcohol. After standing two or three days bottle the clear cider. In order to produce slow fermentation, the casks containing the fermenting liquor must be bunged up tight.

Removal of Tan, Freckles, etc.—For the removal of tan or freckles, a preparation described as "Jour d'Ete" is made with the following formula:

Sulphur precip....	2 parts.
Zinc oxide	1 "
Lanolin.....	2 "
Oil amygd	2 "

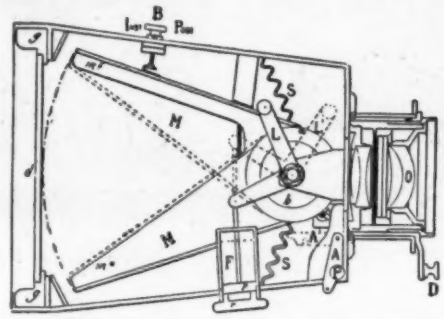
This is perfumed according to taste.—Magazine of Pharmacy.

* In warm weather increase the gelatine to 4 pounds.

HAND CAMERA AND NOVEL FOCAL PLANE SHUTTER.

THE new 3·5 × 4·5 inch hand camera shown in the accompanying figure is provided with the Hanan-Richard magazine and presents the peculiarity of being provided also with a novel focal plane shutter of special form devised by Messrs. Lansiand & Lievrard.

Behind the objective, o, upon a drum closing the bellows, S, there are mounted two jaws, MM, which may be opened, as shown in the figure, so as to completely expose the plate and permit of focusing; but, in their normal position, these jaws are juxtaposed and form a closed box, except at M^a, where there is a slit that corresponds in length to the width of the plate. This box pivots around b, and under the action of a spring passes from M^a to M^b, when the catch, B, of the shutter is pressed. The speed of the shutter is moderated at will by means of an air brake, F, actuated by a lever, L. It will be understood that in the movement of the box, M, the aperture, M^a, traverses the entire sensitized plate to reach M^b, and permits of the action upon all its parts in succession of the luminous rays that come



A NOVEL FOCAL PLANE SHUTTER.

from the objective, o. As in all focal plane shutters based upon this principle, a maximum effect of the light is here obtained.—Photo. Gazette.

THE RELATION OF THE MODERN SYSTEM OF INDUSTRY TO INTELLECTUAL DEVELOPMENT.*

THERE have been in the world three great systems of labor, of industry. The first was slave labor; the second, that under the feudal system; and the third, the present system, or what is known as the wage system, under which men are free to contract their services as well as their goods. These systems have not existed in all cases in chronological order as stated, but they have been clearly defined.

Under the slave system and under that of the feudal order, hand labor was all that was employed. This system of labor we speak of as the domestic system; and it existed in the whole world, even where commerce had made an impression, until about 120 years ago, and it exists now in many parts of the world; but in the great nations of progress the domestic has been superseded by the factory system, or, what is a better form, "the associated system of labor." The domestic or hand system, even now, is the idyllic one: and at the present time, when the air is full of socialism, social democracy, philosophical anarchism, nationalism, and various other methods or systems or philosophies for the regeneration of the race through the industrial order, the domestic system has peculiar fascinations.

In its origin the factory system found its application in the textile trades of England, but it now in reality embraces nearly all lines of machinery. A factory per se is an establishment where several workmen are collected together for the purpose of obtaining greater and cheaper conveniences for labor than they could procure individually at their homes; for producing results for their combined efforts which they could not accomplish separately; and for saving the loss of time which the carrying of an article from place to place during the several processes of its manufacture would occasion. The principle of a factory is that each laborer, working separately, is controlled by some associating principle, which directs his producing powers to effect a common result, which it is the object of all collectively to attain. Factories are, therefore, the legitimate outgrowth of the universal tendency to association which is inherent in our nature, and by the development of which every advance in human improvement and human happiness has been gained.

I am well aware that I am speaking against popular impression, and largely against popular sentiment, when I assert that the modern system in every respect is vastly superior as an element in civilization, as a power in intellectual development, to the domestic system which preceded it; and that the social and moral influences of the present outshine the social and moral influences of the old. I am also aware that the condition of the workers of society has never been the ideal one, and that the evils of the present are sufficient to call out all the sentiments of justice and philanthropy which enable us to deal with wrong and oppression; yet I am fully aware, from a long and careful study of the two systems, from an examination of them where they coexist, as in some parts of the industrial world, that with all its faults and attendant evils, the present industrial system is a vast improvement upon the domestic system in almost every respect.

I cannot go into details, wherein I might more specifically draw the lines between the ignorance under the old system which simply added to the squalor of the homes under it, the spasmodic nature of the work, the unsystematic methods belonging to it, and the regular order maintained under the modern system. I can only suggest these. But as one striking illustration, let me say to you that a modern factory, even a poor one, is a better place to live in than the homes under the old system, and, in fact, many of the homes at present. It has been shown in evidence that no part of a cotton mill is one-tenth part as crowded or the air in it one-tenth part as impure as the Houses of Parliament with a moderate attendance of members. This is perfectly true; and the poorest factory in this country is as good a place to breathe in as Representative Hall during a session, or an ordinary school room. Bad air is one of the surest influences to intemperance; and it is clearly susceptible of proof that intemperance does not exist, and has not existed, to such alarming degrees under the new as under the old order.

The modern system brings mental friction, contact, which could not exist under the old; it brings progress and intelligence; it establishes at the centers the public hall for the lyceum and the concert, and even literary institutions have been the result of the direct influence of the system. As an educational force its power was first illustrated in the efforts made by the philanthropists of England to bring the children under educational influences. It is a curious fact that while England paid no attention whatever to the general education of children, the congregation of children in the factory called attention to their ignorance and thus led to the establishment of the English factory school. The great questions were then asked: Has the nation any right to interfere with social and educational conditions? Shall society suffer that individuals may profit? Shall the next and succeeding generations be weakened morally and intellectually that estates may be enlarged?

For the first time there appeared some of the consequences of congregated labor, or rather the effects of the congregation of one class of labor appeared, and these questions that I have cited arose. They pressed themselves upon the public mind with such force that the answer became not only effective at the time, but potent in establishing an enduring principle; for under the legislation of England the education of factory children was provided for; and this stimulation given to the diffusion of intelligence among factory labor was the sowing of the seed, so far as England is concerned, of the elements of her national school system, from which there has come a pressure upward in all directions. The influence of the new order in this way has been clearly marked. . . .

The modern system is the result of the working of mechanical powers, of machinery. Machinery becomes the type and the representative of the civilization of this period, for it embodies, so far as physics and mechanics are concerned, the concentrated, clearly wrought out thought of the age. Books may represent thought; machinery or invention is the embodiment of thought; and so from an intellectual point of view it becomes perfectly legitimate to speak of the modern system as potent in stimulating intellectual attainments. We are living in the age of intellect, of brain, and it is the age of machinery. Brain is our king and machinery is our king's prime minister.

One of the inevitable results of this régime of machinery has been to enable man to secure a livelihood in less time than of old. This alone bespeaks intellectual development; for it must be considered that as the time required to earn a living grows shorter, civilization advances, and that any system which demands of a man all his time or the greater portion of it, even, for the earning of mere subsistence, is demoralizing in all respects. It is this condition that clings around people that are given to agriculture alone. They rarely progress. There may be great statesmen now and then coming from their ranks; but the general diffusion of knowledge cannot be gained except in the communities where industry is varied, and comprehends a great proportion of mechanism. Under the old system beauty and art were for the few. Under the new system the mechanic has grown to the artisan and the artisan to the artist.

The intellectual development under this age has cured the difficulties in the way of national and grand movements which beset the governments before this epoch; and now the great engineering enterprises that are being developed are solving many of the problems that have disturbed the philosophers of the past. Can there be anything but intellectual stimulation out of the benefits of the modern system, like the reduction of working time, the increase of wages and the decreased cost of production?

And these benefits particularly mark this century; and they have given to the common man a wonderfully enhanced power to command what rulers a century ago, with all the appointments of war and the adjuncts of unlimited exchequers, could not command. Can there be anything but intellectual improvement from the realization that there could have been a time when a linen sheet was worth thirty-two days of hard common labor, and now it can be produced as the result of but a few hours of labor? It is hard to understand that even within the memory of men now living the first change in the speed of transportation or in the interchange of intelligence came to the world. . . .

To create is the province of the Omnipotent; the second great attribute, through the agencies established by Omnipotence, is to develop, and this allies man to his creator; and this power has been secured through the modern system of industry. All these things are working many changes in thought, not only in relation to mechanics, but to ethics, to the social problem, and to all that belongs to the social order.

Commerce and industry, in order to meet the requirements of man, produce conditions which, as I have said, appear to us to be evils that have been created. They are the appearances and not the realities. The realities lie in the fact that the conditions of the poorest are improved. The very mechanical movements which are essential to the successful working of a great machine wear away the crudeness of mental conditions and brighten the intellects even of the ignorant.

Whatever elevates, enlarges and expands the soul renders it more capable of succeeding in those very undertakings which concern it. I, therefore, find great moral and intellectual lessons in studying industrial conditions. The social fabric is destroyed or preserved as the industrial basis is elevated or degraded. . . .

My respect and admiration for the producers working under our modern industrial system—men of skill, bright, intelligent citizens—prevent me from bringing them into comparison with the clods who sullenly performed their work under the old system. I am perfectly well aware that here and there in any country there can be found dens and hovels in which men and families devoted to industrial pursuits find what they call their homes. I have seen such. I can find them in my

* From an address delivered at Pratt Institute.—From the Pratt Institute Monthly.

own State and probably in every State in the Union. I can find them in England and in every Continental country. But they are the exceptions. In Manchester, England, sixty years ago, sixty thousand factory operatives were living underground in cellarages. To-day you cannot find one family belonging to the industrial classes living in such a hole. I have looked into a thousand homes of the working people of Europe; I do not know how many in this country. I have tried to find the best and the worst. And while, as I say, I am aware that the worst exists, and as bad as under any system or as bad as in any age, I have never had to look beyond the inmates to find the cause; and in every case, so far as my own observation goes, drunkenness was at the bottom of the misery and not the industrial system or the industrial conditions surrounding the men and their families.

To-day the whole matter of the consideration of the condition of the workingmen becomes intellectual. He is carried onward and upward by the power of mental activity, and cannot be treated separately as one of a class, as he could in the olden time, because in the olden time he was neither a social nor a political factor. Changed conditions in all directions have brought mankind to a new epoch, the distinguishing feature of which is machinery. CARROLL D. WRIGHT,
United States Commissioner of Labor.

MR. GRIFFITH ON THE TESTING OF SMOKELESS POWDERS.*

A HEADING such as the above cannot but arouse the interest of all who are in the slightest way concerned with the manufacture of guns or of small arms powder. As practically the original chemist and superintendent of the pioneer smokeless powder factory of Great Britain, and we think we might say almost of the world, Mr. Griffith has an experience unequaled in the annals of this industry. In the early days of the Schultze Gunpowder Company, the difficulties which faced them appeared almost insuperable; and at the time when Mr. Griffith was engaged to take charge of the factory where Col. Schultze's products were being exploited a great deal remained to be done before smokeless powders could be considered in any way a reliable substitute for black powder. The chemical properties of smokeless powder necessitated in their manufacture a very much more detailed knowledge of the forces which have to be controlled than in the case of black powder, and the man who would have a smokeless powder in those days had first to invent the machinery and apparatus for obtaining an exact record of its various physical properties.

Mr. Griffith's early days were, therefore, occupied as much, if not more, with problems connected with the measurement of the ballistic effects of his powders as with the questions more intimately connected with the powder itself. He was, however, eminently successful; and, as his inquiries proceeded on the lines dictated by sound scientific knowledge and by a practical mind, he has originated ideas, and formulated these into theories which are now universally accepted as being at the root of the questions with which they deal. For these and other reasons, which do not require further specification, we were led to anticipate that the lecture which Mr. Griffith arranged to deliver on the occasion of the visit of the Gunmakers' Association to the Schultze Gunpowder Factory would be in its way a record, and we can only say that our anticipations have been justified to their fullest extent.

While this account does not in any way profess to be a verbatim record of what was said, at the same time its substance is given without material deductions. Here and there certain points have been somewhat expanded, as the sense of the lecture in a measure depended upon the apparatus displayed, or on the information which had been obtained prior to the lecture by the visitors in their inspection of the works and laboratories.

The lecturer opened his remarks by referring to the gradual evolution which had brought into existence the present methods of testing the strength of modern small arm compounds. He explained that before smokeless powders were brought forward, the system adopted was of observing the recoil of the gun and assuming that the penetration would be proportional. When smokeless powders came into general knowledge, however, the extraordinary diminution of the recoil, accompanied as it was by an equally effective flight of the charge of shot, rendered this method of comparison useless, and it became necessary to cast about for some more reliable alternative.

About the year 1870 the great point aimed at was the penetration, and it was this which all the tests of that period attempted to establish. The measurements were taken at a range of forty yards, and it was sought, by working with various forms of targets, to obtain a reliable record of this factor in the travel of the shot. Mr. Griffith explained that he had made exhaustive tests in this direction, and that among the devices employed were the following: Movable targets on wheels, paper pads, tin sheets, wax cakes, water targets, field force gages, Pettitt's pads, copper sheets, levers and pendulum, straw boards, lead sheets and cardboards. All of these gave some information, but none proved to be reliable in all cases.

Meanwhile Mr. Griffith kept the problem of ascertaining the internal pressure of the gun fully in view, and he sought by various devices to find a practical solution of his desires. His first move in the direction of the measurement of pressure was to obtain from Birmingham a number of cheap gun barrels. These he tested with successively increasing charges of powder until he arrived at a point where, by careful measurements, it became apparent that the capacity of the gun to resist the internal pressure had been exceeded. Having established this point, it was possible to know whether a certain batch of powder gave results within the limits of the strength of an ordinary gun barrel. In 1878, however, the first plug gun was made, and it was produced at the lecture. It had an eight-bore barrel, and resembled nothing more closely, owing to the noble dimensions of its form, than a small cannon. The principle, however, was there. Holes were drilled into the bore of the barrel, and these were stopped up with movable plugs, which in their lowest position came flush with the surface of the bore. The pressure of the powder gases inside this gun was resisted by various means, which included such devices as dead weights which operated on the plug through the medium of levers, dead weights directly connected to the plug, and springs acting with a very high tension on the plug. These devices were far from perfect, but, nevertheless, they gave very favorable data.

This gun was followed in the year 1886 by a lead crusher gun, which was the pioneer of the at present very successful system of plug guns and lead crushers. The plan adopted consisted of placing small cylinders of lead on to the top surface of the plugs, which were at their lower ends exposed to the action of the powder gases. A screw was brought down on to the top of the lead cylinder, and the effect of the explosion was to drive up the plug so as to cause a compression of the lead cylinder against the rigid screw which held it above. These lead crushers gave regular measurements, but the great difficulty was to translate them into pounds per square inch.

Mr. Griffith found it necessary in those days to manufacture his own lead crushers, as he found that nothing he could procure in the market was sufficiently accurate in the leading points on which correct results depended. For instance, lead crushers cannot give reliable results unless their dimensions, their weight, and their hardness are true and uniform. His modus operandi in their manufacture was as follows:

Cylinders of lead, as nearly as possible of the correct form, were placed in a press where a uniform blow was struck upon each. The ends were then carefully trued up, and if their weight then proved to be uniform, they were passed as ready for use. Since then, however, Messrs. Eley Brothers, Limited, have undertaken their manufacture, and the results have been of a most satisfactory character. The crushers made by this firm possess all the features of accuracy which the delicate nature of the experiments for which they are to be used require. There is thus no further need to continue the arduous work of manufacturing them on a small scale.

The pressure guns have, since the manufacture of Mr. Griffith's pioneer type, scored an equally satisfactory advance at the hands of Messrs. Cogswell & Harrison, and nothing better could be desired than the various pressure guns put upon the market by them. There are various types of these guns, but the most generally used is that in which there is a single plug at one inch from the breech face. There are others, however, in which a series of plugs are placed all along the barrel, thus enabling the pressure to be taken at other distances from the breech face. We illustrate one of these guns herewith (Fig. 1), and it will be seen to consist of a square block bored internally to the required size of gun. The series of plugs are fixed at the following measurements from the breech face, viz., 1 in., 2½ in., 6 in., 9 in., 12 in., 18 in., 24 in. The plug, a, is in communication with the bore of the gun, and the lead crusher, b, is shown with the binding screw, c, holding it in place. The weapon is closed by a suitable form of breech block, and the firing pin, d, is operated by a lanyard. These crushers give remarkably true results, and though there is no way of translating their results into the recognized units of pressure, for comparative purposes, they are extremely valuable. It has been the custom, however, to give equivalents for various crushings in a series of tables in tons per square inch; and although there is no theoretical justification for the actual values assigned, Mr. Griffith expressed the opinion that the table of equivalents, as issued by Messrs. Eley Brothers, went, as far as he could judge from the exhaustive experiments he has made, extremely near to the truth. He used these equivalents in all his experiments, and he was pleased to take the present opportunity of acknowledging his indebtedness to the company for them.

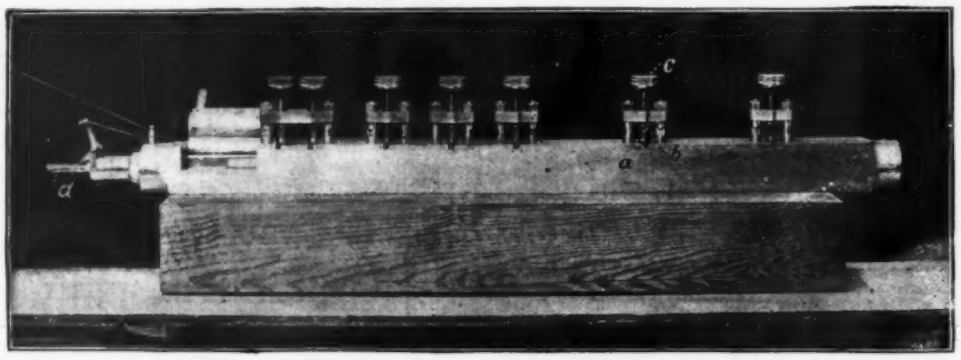


FIG. 1.—COGSWELL & HARRISON'S PRESSURE GUN.

There was one point, however, to which he would like to call attention. It was that the duration of the pressure producing the crushings had a considerable effect on the results, and that unless account was taken of this factor, the readings might appear to be misleading. The following table gives a record of the results obtained from the above gun with various powders, in which will be seen that Schultze powder gives a pressure at one inch of 2·55 tons per square inch, as compared with a condensed powder in a coned case of 2·10 tons, while at 2½ in. Schultze gives 2·62 tons and the condensed powder 2·25 tons.

TABLE OF PRESSURES IN A 12 BORE BARREL, IN TONS PER SQUARE INCH, TAKEN BY LEAD CRUSHERS.

	At from the Breech.						
	1 in.	2½ in.	6 in.	9 in.	12 in.	18 in.	24 in.
Black No. 2	3·16	2·90	1·42	1·28	1·25	1·25	1·15
" No. 4	2·60	2·40	1·45	1·28	1·25	1·25	1·20
" No. 6	2·15	2·04	1·55	1·40	1·28	1·28	1·25
Schultze	2·55	2·62	1·48	1·30	1·25	1·25	1·20
A condensed powder in coned case	2·10	2·25	1·50	1·25	1·20	1·15	1·05
Do. in ordinary case	3·45	2·56	1·50	1·25	1·20	1·15	1·05

On the face of it there appears to be no explanation of this, but the following table, which is a record of the time occupied by the charge of shot in traversing the various sections of the length of the barrel, throws some light on the point. We will explain further on how the measurements are obtained: but for the time being it will be sufficient to indicate that the figures represent the number of ten-thousandths of a second taken up by the charge in traveling, first from the car-

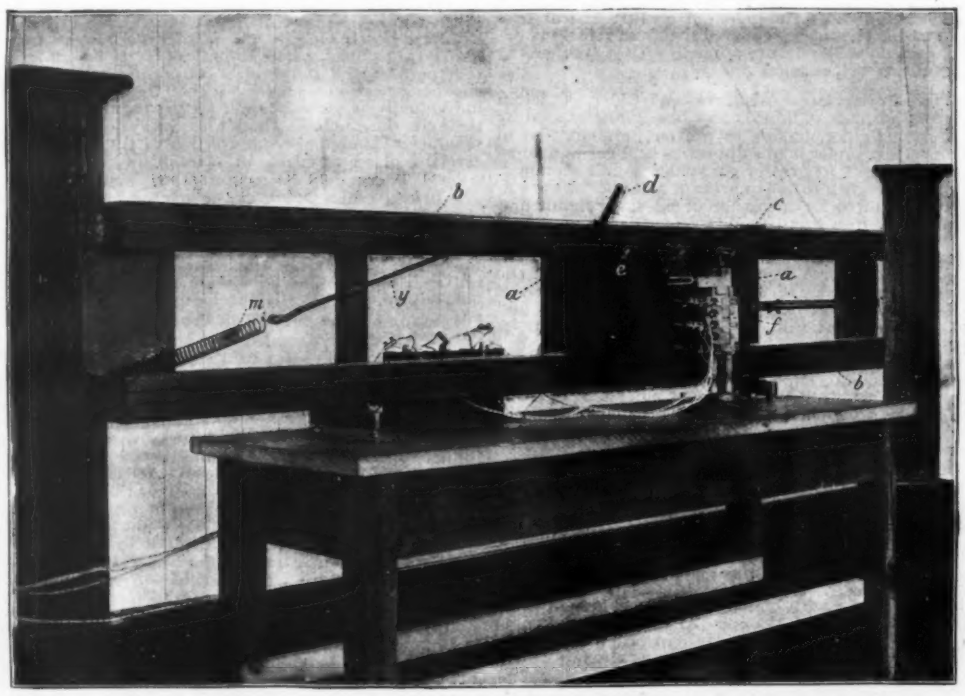


FIG. 2.—PROF. SMITH'S CHRONOGRAPH.

* For our engravings and the description we are indebted to our English contemporary Arms and Explosives.

tridge case to three inches up the bore; second from three inches to six inches, and so on.

TIME TAKEN IN TRAVEL OF SHOT IN A 12 BORE BARREL, TAKEN AT VARIOUS POINTS BY A SMITH CHRONOGRAPH, IN TEN-THOUSANDTHS SECOND.

	Cap to 3 in.	3 in. to 6 in.	6 in. to 12 in.	12 in. to 18 in.	18 in. to 24 in.	24 in. to 30 in.	Total time in barrel in seconds
Black No. 2.....	72	45	55	45	35	30	0·00282
" No. 4.....	138	52	61	50	40	34	0·00375
" No. 6.....	162	55	65	56	45	37	0·00420
Schultze.....	275	46	57	48	40	34	0·00500
Condensed in coned case	72	44	57	48	42	37	0·00300
Do. in ordinary case. .	100	45	58	49	42	36	0·00329

It will be seen from the second table that while the record of pressure of 2·55 tons per square inch was obtained with Schultze powder, the pressure producing it was applied during a period of 0·0275 of a second, while with the condensed powder the recorded pressure of 2·10 tons per square inch was obtained with a duration of pressure amounting to only 0·0072 of a second. Of course, it would not be necessary to take these time results in every case, because with the same powder the above general characteristics of time are maintained with a considerable amount of uniformity, and may therefore be remembered accordingly.

While the rough and ready method of testing the violence and penetration of a gun by noting the sensation of recoil felt on the shoulder gave way, on the one hand, to pressure tests along the barrel, it was replaced, on the other, by velocity tests between the muzzle and the target, which are now about to be described. The method adopted consisted in measuring the period occupied by the shot in traveling from the muzzle of the gun to the target at 40 yards, and calculating from this the mean velocity over the distance. For this the Boulengé chronograph was used, and it was sufficiently accurate in itself, though at first there was a difficulty in taking accurate records owing to the "stringing" of the shot. The cause of this difficulty was that a number of pellets reached the target much in advance of the main body of the charge, and, severing the electrical connection, gave a wrong idea as to the time of the arrival of the main body of the charge. The problem to which this gave rise was to find a means of eliminating the first arrivals, and this was satisfactorily accomplished in the year 1883 by means of what is known as the sectional target. We may mention, for the information of our readers, that a full description of one of these appeared in our June issue of last year.

The lecturer explained that it would not be necessary for him to give any long description of the method of working the Boulenge chronograph, as it had been out so many years that almost everyone was already acquainted with it. The general principle of it, however, is that two weights are suspended from a pair of electromagnets, which, on a severance of electrical current, cease to be magnets and allow the weights to fall. One weight falls when a wire is cut at the muzzle of the gun, and the other falls when the charge reaches the target. When the second weight falls, it operates a knife, which, making a dent on the first falling weight, shows the distance it had traveled before the other began to move, and from this is deduced the time occupied, and thence the mean velocity.

The disadvantages of this apparatus, however, render it in some ways unfit for the class of work required of it in an explosive factory. In the first place, a reading can only be effected between two points of time. In the second place, the electromagnets are liable to what is known as "residuary magnetism," which is a property they have under certain conditions, to retain enough attractive power, after the circuit has been broken, to delay the fall of the iron weight attached to it. Another disadvantage is that the records of time cannot be taken with the desired amount of fineness. Furthermore, the rate of fall is dependent on the altitude of the particular place where the tests are made; in other words, the gravitational force is not of constant value at all places. Another point is, that the effect of the air resistance cannot be taken into account.

The most important of the above objections is, however, that the periods of time are not measured to a sufficiently fine degree; because it soon became apparent, in testing the velocity at 40 yards, that a number of outside factors were introduced which might materially affect the results, but which have no bearing on the efficiency or otherwise of the explosive. Among these may be mentioned the fact that the boring of the gun materially alters the velocity that the charge of shot retains beyond, say, five yards. What was really required was a more delicate chronograph which is sufficiently sensitive to measure the velocity over the first five yards from the muzzle, and which could take several records at the same time. One of the effects of measuring the velocity at five yards is that the stringing of the shot has not yet commenced to take place, and consequently any wires that may be severed at that distance are broken practically simultaneously by the whole charge.

The Smith chronograph fulfills these requirements, for it registers readily an interval of 0·0001 of a second, and may be used to take simultaneous records. An illustration of this chronograph is given herewith (Fig. 2), and it will be seen to consist of the carriage, a, which travels in guides from one end to the other of the frame, b. The carriage is forced up to the right hand end against the pressure of a spring, and when it has reached its ultimate position it is automatically locked by means of the catch, c. The handle, d, is connected with the catch holding the carriage in check. This gun is fixed, as shown in our illustration of the trial gallery (Fig. 3), and wires communicate between it and the chronograph. The muzzle of the gun is pointed to the cast iron block, z, which is suspended in the air, and which has wires fixed across the hole in the center, which are broken by the shot pellets. Returning to the chronograph, attention should next be called to the glass plate, e, which is fixed on the carriage. This glass plate is evenly smoked over the surface by means of a benzine lamp, and it is by the markings on this plate that the records are obtained.

The medium for producing the marks is the electrical marker, f, which is shown separately in Fig. 4. It consists of a tuning fork, g, which is adjusted so as to give the musical note which corresponds to 10,000 beats in a second, or any other that may be decided upon. The tuning fork is provided with a scratching point, h, which comes into contact with the surface of the smoked plate of glass. Three other indicators, i i i, are arranged beneath this, and they will be seen to consist of scratching points, j, which are actuated by electromagnets, k. In order to fire the gun and obtain these records of time, the tuning fork is given a slight tap, and immediately afterward the handle, d, is pulled. The pulling of this handle serves to release the sliding carriage, a, of the chronograph, which in its turn discharges the gun at the proper point in its course. As the sliding carriage slides along the frame, the point, h, of the vibrating tuning fork scratches a wavy line on the smoked surface of the glass plate. The recording magnets, k, are actuated when the charge leaves the muzzle, and when the shot has traveled five yards, or otherwise according to the arrangement of the connections for the particular test in progress, in the following manner: These points are mounted so that a spring is always tending to pull them upward. Some very small magnets, so small in fact as to diminish within reasonable proportions the tendency to residual magnetism, are arranged to hold the pointers in a downward position. When the electrical circuit is broken, the magnets, losing their power,

FIG. 3.—TRIAL GALLERY.

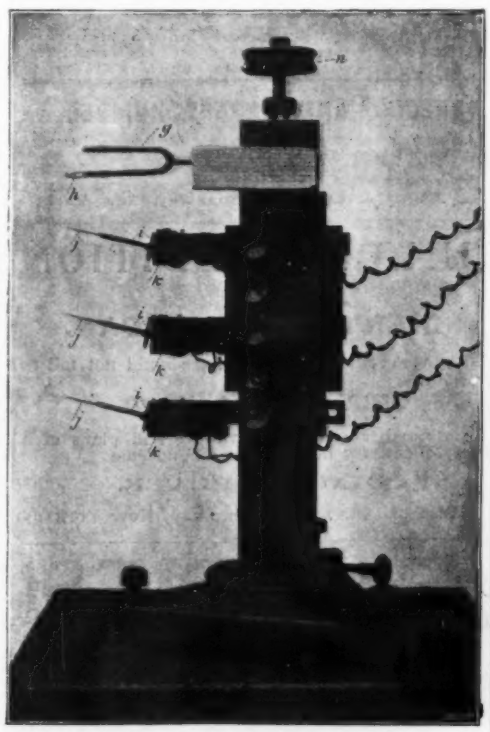


FIG. 4.—MARKER FOR SMITH'S CHRONOGRAPH.

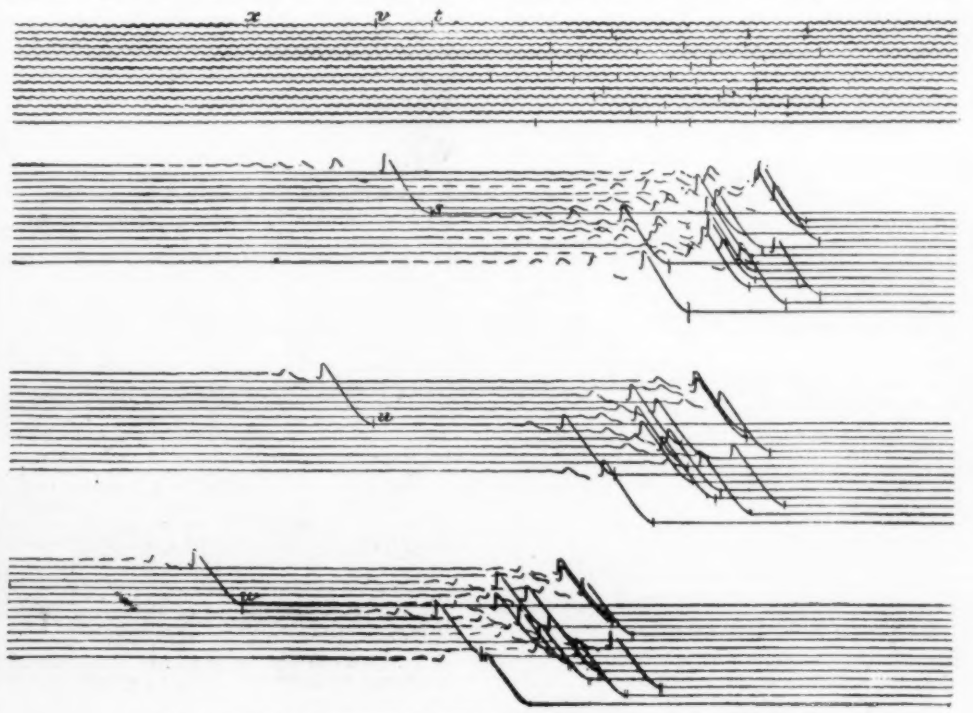


FIG. 5.—ACTUAL RECORDS WITH A SMITH'S CHRONOGRAPH.

allow the spring to pull the pointer upward, and the line, which the pointer was previously scratching on the smoked surface of the glass plate, takes a sudden turn upward and then continues to describe the line in its new position. The carriage, having passed beyond the electrical marker, is brought up by coming into contact with the piece of leather, l, which is kept taut by the spiral spring, m. When a record has been obtained on the above principle, the screw, n, which is shown on the electrical marker, is given one turn, and this has the effect of bringing each of the scratching points a little lower down and so opposite to an unscratched portion of the smoked glass plate, and after reloading the gun, a fresh series of measurements may be made.

In order to make it clearer as to how these records are obtained, we reproduce in Fig. 5 a series of actual readings which were obtained on this principle. It may be explained that when it is required to keep a permanent record of one of these plates, all that is necessary is to treat the smoked plate with the scratches on it as a photographic negative, and print off from it as many copies as may be required. Our illustration represents a print obtained by this means. It will be seen that the plate contains a record of no less than fourteen sets of measurements. The wavy lines of the top band of scratchings are those made by the tuning fork, while the remaining three bands are those produced by the electrical markers. The top wavy line corresponds with the topmost scratching of each of the three bands beneath. The second wavy line corresponds to the second scratching of each of the series of lines beneath, and so forth. The top series of lines may, for the sake of an example, be taken to represent the point at which the first wire was broken by the fall of the hammer; the next series of lines may be taken to represent the time at which the charge arrived at the muzzle; and the third series of lines may be taken to represent the arrival of the shot at five yards from the muzzle. The edges of the glass are made strictly square, and all that is necessary is to mark off on the corresponding position on the line of waves a line opposite to where the electrical indicator commences to give the line an upward turn. Dealing only with the first reading, it will be seen that the mark, s, has been projected into its corresponding position, t, on the wavy line. Further, the mark, u, has been projected to the position, v, and the mark, w, to x. It will be seen that there are thirteen distinct waves between t and v, and six waves between v and x, which establishes that 0·0013 of a second were occupied by the period from the fall of the hammer to the arrival of the charge at the muzzle, and 0·0007 of a second for the charge to travel from the muzzle to the 5 yards target. Of course it will be understood that these explanations of the table are purely fanciful, as we have no record before us as to what the actual results are which were being taken on the plate before us. The above supposed measurements on our part would give a velocity of 21,000 odd feet per second, which is of course ridiculous. We do not even know which tuning fork produced it, for, as a matter of fact, there are several sizes which give widely different number of beats per second according to the nature of the work in hand.

It should always be remembered that any number of marking points may be used together, all that is necessary being to increase the glass plate to a size sufficient to receive all their impressions.

An important use to which this chronograph has been put is the previously noticed measurements of the time occupied by the charge of shot in traversing the successive sections of the barrel's length, and this is done in a fairly simple manner. Instead of connecting the wires from the electrical indicators of the chronograph to the muzzle of the gun, etc., they are carried to the special gun, which we illustrate herewith (Fig. 6). It is known as the plug gun, and it will be seen to consist of a shot gun with a Martini action. The barrel of the gun is perforated at intervals in its length at the distances indicated in the second of the tables quoted at the commencement of this article. While these holes are so small that the escape of gas through them, if left open, would not amount in a loss resulting in more than one foot per second in the muzzle velocity of the gun, they are at the same time sufficient to enable the operator to introduce into it an electrical conductor, which is broken by the charge as it passes that particular point along the barrel. The term electrical conductor is used advisedly, because an electrical wire would not give results of sufficient accuracy; for the passage of the charge would not cause the instantaneous fracture required. The wire would be drawn out for some distance beyond the point where nominally it would be supposed to have broken. Furthermore, the drawn out ends of the wire might prevent the complete breakage of the electrical circuit, as they would be quite likely to be carried beyond the insulating plugs in which they would have to be embedded, and thus they would maintain the continuity of the circuit by pressing against the sides of the barrel or against the charge of shot.

The way in which this difficulty has been overcome is most ingenious. As is known to most of us who have done any glass blowing, a piece of glass tube, if warmed in the center and pulled out, may be drawn to a thread as fine as a hair, and yet with all this the minute hair still remains as perfect a tube as the original one from which it was drawn. Mercury is filled into a short length of a suitably fine tube obtained by this means, and the ends of this capillary tube (as it is known to scientists) are connected to short wires, which in turn are connected with the electrical markers on the chronograph. The required number of these glass tubes is put into the gun, and the charge may always be relied upon to produce an instant interruption of the electrical circuit established through them.

This is the way our second table was arrived at, and it is unnecessary to point out that the results are obtained from the mean of a number of shots fired presumably in two series, as the particular chronograph here illustrated is only provided with three electrical markers. The most interesting feature of the plug gun, which gives us measurements of the periods of time occupied by the shot along the barrel, is the fact that it enables us to establish a certain practical relationship between the records with lead crushers and their so-called equivalents in tons per square inch. It is known to all, that the gravitational attraction of the earth produces a definite ratio of increase of velocity in bodies allowed to fall freely under its influence. In exactly the same way it is a simple problem in applied mechanics to produce from the velocity acquired by a charge of shot of a known weight, over a known distance, the effective mean pressure which brought this about. Thus, turning to table I with Schultze powder, we know that, from a state of rest, the shot reached three inches during a period of 0·0275 of a second, and from three inches to six inches there was such an increase of velocity that this distance was traversed at 0·0046 of a second. From these figures the effective pressure which produces these results can be deduced and the pressure so calculated can be compared with the amount of crushing which the leads receive. Though such calculations can take no account of the pressure in the gun, which was neutralized by the friction of the charge up the barrel, they give extrmely valuable results for comparative purposes.

In our illustration of this gun, p shows the places where holes have been made in the barrel for the reception of the capillary tubes, and o is a sleeve fixed on the holes where tests are being made, and it is used for holding the insulated terminals for the electric circuit.

In connection with the general question of measuring the velocity of shot guns, it may be interesting to point out that the records show a gradual improvement during the past twenty years. In 1878 the acknowledged standard velocity was 845 foot seconds. In 1886 it had risen to 855 foot seconds, and now an average of 870 to 880 foot seconds can be relied upon at 40 yards with No. 6 shot. From this there appears to be every prospect of reaching a muzzle velocity of 900 foot seconds without disturbing the excellent patterns given with the lower values at present in use.

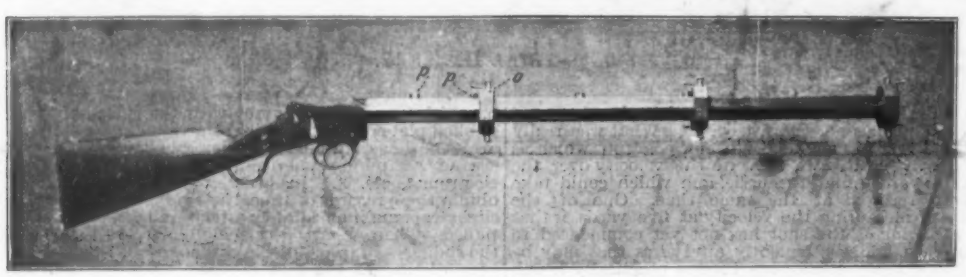


FIG. 6.—PLUG GUN.

Mr. Griffith, in continuing his lecture, explained that the method in use at the Schultze factory is to test chemically for purity daily, and with the above apparatus for the internal pressure and velocity. The powder is then stored away for three months, when the tests are repeated, and the results are also taken at 40 yards simultaneously with an observation of the patterns produced. In reference to patterns, however, Mr. Griffith explained that that was a question which concerned more closely the ammunition manufacturer and the gunmaker. The powder imparts a given velocity to the shot at the muzzle, and it remains with the ammunition and the gun to insure that that velocity was suitably utilized, and that the resulting patterns should be in accordance with the requirements of the sportsman.

In conclusion, the lecturer explained that though some portions of the work of a gunpowder manufacturer and tester had not yet become an exact science, at the same time, when one considers the many side issues which, though not capable of independent estimation, may materially affect the results, the progress so far obtained appears extremely satisfactory from the practical point of view.

Among the different points influencing the science of ballistics may be mentioned the following: Charge of powder, charge of shot, composition and quantity of primer, flash hole, wadding, stiffness of paper tube, turnover, boring of gun, shape of cone, choking. When all of the above are considered, it seemed to the lecturer that the powder manufacturer and the gunmaker may be congratulated on the excellence and regularity to which their various manufactures have attained.

This concluded what we think may always rank as one of the most interesting lectures which have ever been delivered on the subject of shot gunpowders. The lecturer had many difficulties to contend with, among which was the fact that his time was severely cut down. We can only hope that some time in the future he may be induced to book an engagement in London, where he may lecture before the gunmakers' association in one of the well-known lecture halls of the metropolis. On such an occasion the absence of the actual apparatus would have to be counteracted by a series of limelight views.

We are convinced, however, apart from what may be done in this way in time to come, that a step has been made in the right direction in bringing such interesting matters intimately before gunmakers, and to Mr. Griffith is due the credit for having shown how inviting these apparently remote theories may be made at the instance of one who has a lifelong familiarity with them.

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